COURSE STRUCTURE AND SYLLABUS

For

ELECTRICAL AND ELECTRONICS ENGINEERING

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Year – I Semester

S. No	Subjects	L	T	P	Credits
1-HS	English – I	4	--	--	3
2-BS	Mathematics - I	4	--	--	3
3-ES	Applied Chemistry	4	--	--	3
4-BS	Engineering Mechanics	4	--	--	3
5-BS	Computer Programming	4	--	--	3
6-ES	Environmental Studies	4	--	--	3
7-HS	Applied / Engineering Chemistry Laboratory	--	--	3	2
8-BS	English- Communication Skills Laboratory - I	--	--	3	2
9-ES	Computer Programming Laboratory	--	--	3	2
	Total Credits				**24**

I Year – II Semester

S. No	Subjects	L	T	P	Credits
1-HS	English – II	4	--	--	3
2-BS	Mathematics – II (Mathematical Methods)	4	--	--	3
3-BS	Mathematics – III	4	--	--	3
4-ES	Applied Physics	4	--	--	3
5	Electrical Circuit Analysis - I	4	--	--	3
6-ES	Engineering Drawing	4	--	--	3
7-BS	English - Communication Skills Laboratory - II	--	--	3	2
8-HS	Applied / Engineering Physics Laboratory	--	--	3	2
9-ES	Applied / Engineering Physics – Virtual Labs - Assignments	--	--	2	--
10	Engg.Workshop & IT Workshop	--	--	3	2
	Total Credits				**24**

II Year – I Semester

S. No	Subjects	L	T	P	Credits
1	Electrical Circuit Analysis - II	4	--	--	3
2	Electrical Machines-I	4	--	--	3
3	Basic Electronics and Devices	4	--	--	3
4	Electro Magnetic Fields	4	--	--	3
5	Thermal and Hydro Prime Movers	4	--	--	3
6	Managerial Economics & Financial Analysis	4	--	--	3
7	Thermal and Hydro Laboratory	--	--	3	2
8	Electrical Circuits Laboratory	--	--	3	2
	Total Credits				**22**

II Year – II Semester

S. No	Subjects	L	T	P	Credits
1	Electrical Measurements	4	--	--	3
2	Electrical Machines-II	4	--	--	3
3	Switching Theory and Logic Design	4	--	--	3
4	Control Systems	4	--	--	3
5	Power Systems-I	4	--	--	3
6	Management Science	4	--	--	3
7	Electrical Machines -I Laboratory	--	--	3	2
8	Electronic Devices & Circuits Laboratory	--	--	3	2
	Total Credits				**22**

III Year – I Semester

S. No	Subjects	L	T	P	Credits
1	Power Systems-II	4	--	--	3
2	Renewable Energy Sources	4	--	--	3
3	Signals and Systems	4	--	--	3
4	Pulse & Digital Circuits	4	--	--	3
5	Power Electronics	4	--	--	3
6	Electrical Machines-II Laboratory	--	--	3	2
7	Control Systems Laboratory	--	--	3	2
8	Electrical Measurements Laboratory	--	--	3	2
9-MC	IPR & Patents	--	2	--	--
	Total Credits				**21**

III Year – II Semester

S. No	Subjects	L	T	P	Credits
1	Power Electronic Controllers & Drives	4	--	--	3
2	Power System Analysis	4	--	--	3
3	Micro Processors and Micro controllers	4	--	--	3
4	Data Structures	4	--	--	3
5	Open Elective 1. Unix and Shell Programming 2. OOPS Through JAVA 3. VLSI Design 4. Robotics 5. Neural Networks &Fuzzy Logic 6. Energy Audit and Conservation& Management	4	--	--	3
6	Power Electronics Laboratory	--	--	3	2
7	Microprocessors & Microcontrollers Laboratory	--	--	3	2
8	Data Structures Laboratory	--	--	3	2
9-MC	Professional Ethics & Human Values	--	3	--	--
	Total Credits				**21**

IV Year – I Semester

S. No	Subjects	L	T	P	Credits
1	Utilization of Electrical Energy	4	--	--	3
2	Linear IC Applications	4	--	--	3
3	Power System Operation & Control	4	--	--	3
4	Switchgear and Protection	4	--	--	3
5	**Elective – I:** 1. Electrical Machine Modeling and Analysis 2. Advanced Control Systems 3. Programmable Logic Controllers& Applications 4. Instrumentation	4	--	--	3
6	**Elective – II:** 1. Optimization Techniques 2. Electric Power Quality 3. Special Electrical Machines	4	--	--	3
7	Electrical Simulation Laboratory	--	--	2	2
8	Power Systems & Simulation Laboratory	--	--	2	2
	Total Credits				**22**

IV Year - II Semester

S. No	Subjects	L	T	P	Credits
1	Digital Control Systems	4	--	--	3
2	HVDC Transmission	4	--	--	3
3	Electrical Distribution Systems	4	--	--	3
4	**Elective – III:** 1. High Voltage Engineering 2. Flexible Alternating Current Transmission Systems 3. Power System Reforms	4	--	--	3
5	Seminar	--	3	--	2
6	Project	--	--	--	10
	Total Credits				**24**

SYLLABUS

I Year - I Semester

L	T	P	C
4	0	0	3

ENGLISH - I

Introduction:

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training the students to acquire communicative competence, the syllabus has been designed to develop linguistic and communicative competence of the students of Engineering.

As far as the detailed Textbooks are concerned, the focus should be on the skills of listening, speaking, reading and writing. The nondetailed Textbooks are meant for extensive reading for pleasure and profit.

Thus the stress in the syllabus in primarily on the development of communicative skills and fostering of ideas.

Objectives:

1. To imporve the language proficiency of the students in English with emphasis on LSRW skills.
2. To enable the students to study and comprehend the prescribed lessons and subjects more effectively relating to their theorotical and practical components.
3. To develop the communication skills of the students in both formal and informal situations.

LISTENING SKILLS:

Objectives:

1. To enable the students to appreciate the role of listening skill and improve their pronounciation.
2. To enable the students to comprehend the speech of people belonging to different backgrounds and regions.
3. To enable the students to listen for general content, to fill up information and for specific information.

SPEAKING SKILLS:

Objectives:

1. To make the students aware of the importance of speaking for their personal and professional communication.
2. To enable the students to express themselves fluently and accurately in social and professional success.
3. To help the students describe objects, situations and people.
4. To make the students participate in group activities like roleplays, discussions and debates.
5. To make the students particiapte in Just a Minute talks.

READING SKILLS:

Objectives:

1. To enable the students to comprehend a text through silent reading.
2. To enable the students to guess the meanings of words, messages and inferences of texts in given contexts.
3. To enable the students to skim and scan a text.
4. To enable the students to identify the topic sentence.
5. To enable the students to identify discourse features.
6. To enable the students to make intensive and extensive reading.

WRITING SKILLS:

Objectives:

1. To make the students understand that writing is an exact formal skills.
2. To enable the students to write sentences and paragraphs.
3. To make the students identify and use appropriate vocabulary.
4. To enable the students to narrate and describe.
5. To enable the students capable of note-making.
6. To enable the students to write coherently and cohesively.
7. To make the students to write formal and informal letters.
8. To enable the students to describe graphs using expressions of comparision.
9. To enable the students to write techincal reports.

Methodology:

1. The class are to be learner-centered where the learners are to read the texts to get a comprehensive idea of those texts on their own with the help of the peer group and the teacher.
2. Integrated skill development methodology has to be adopted with focus on individual language skills as per the tasks/exercise.
3. The tasks/exercises at the end of each unit should be completed by the learners only and the teacher interventionis perimitted as per the complexity of the task/exercise.
4. The teacher is expected to use supplementary material wherever necessary and also generate activities/tasks as per the requirement.
5. The teacher is perimitted to use lecture method when a completely new concept is introduced in the class.

Assessment Procedure: Theory

1. The formative and summative assessment procedures are to be adopted (mid exams and end semester examination).
2. Neither the formative nor summative assessment procedures should test the memory of the content of the texts given in the textbook. The themes and global comprehension of the units in the present day context with application of the langauge skills learnt in the unit are to be tested.
3. Only new unseen passages are to be given to test reading skills of the learners. Written skills are to be tested from sentence level to essay level. The communication formats—emails,letters and reports-- are to be tested along with appropriate langauge and expressions.
4. Examinations:
   I mid exam + II mid exam (15% for descriptive tests+10% for online tests)= 25%

(80% for the best of two and 20% for the other)

Assignments= 5%

End semester exams=70%

5. Three take home assignments are to be given to the learners where they will have to read texts from the reference books list or other sources and write their gist in their own words.

The following text books are recommended for study in I B.Tech I Semester (Common for all branches)and I B.Pharma I Sem of JNTU Kakinada from the academic year 2016-17

(R-16 Regualtions)

DETAILED TEXTBOOK:

ENGLISH FOR ENGINEERS AND TECHNOLOGISTS, Published by **Orient Blackswan Pvt Ltd**

NON-DETAILED TEXTBOOK:

PANORAMA: A COURSE ON READING, Published by **Oxford University Press India**

The course content along with the study material is divided into six units.

UNIT I:

1. 'Human Resources' from English for Engineers and Technologists.
OBJECTIVE:
To develop human resources to serve the society in different ways.
OUTCOME:
The lesson motivates the readers to develop their knowledge different fields and serve the society accordingly.
2. 'An Ideal Family' from Panorama: A Course on Reading
OBJECTIVE:
To develop extensive reading skill and comprehension for pleasure and profit.
OUTCOME:
Acquisition of writing skills

UNIT 2:

1. ' Transport: Problems and Solutions' from English for Engineers and Technologists.
OBJECTIVE:
To highlight road safety measures whatever be the mode of transport.
OUTCOME:
The lesson motivates the public to adopt road safety measures.
2. 'War' from 'Panorama : A Course on Reading'
OBJECTIVE:
To develop extensive reading skill and comprehension for pleasure and profit.
OUTCOME:
Acquisition of writing skills

UNIT 3:

1. 'Evaluating Technology' from English for Engineers and Technologists.

OBJECTIVE:

To highlight the advantages and disadvantages of technology.

OUTCOME:

The lesson creates an awareness in the readers that mass production is ultimately detrimental to biological survival.

2. 'The Verger' from 'Panorama : A Course on Reading'

OBJECTIVE:

To develop extensive reading skill and comprehension for pleasure and profit.

OUTCOME:

Acquisition of writing skills

UNIT 4:

1. 'Alternative Sources of Energy' from English for Engineers and Technologists.

OBJECTIVE:

To bring into focus different sources of energy as alternatives to the depleting sources.

OUTCOME:

The lesson helps to choose a source of energy suitable for rural India.

2. ' The Scarecrow' from Panorama : A Course on Reading

OBJECTIVE:

To develop extensive reading skill and comprehension for pleasure and profit.

OUTCOME:

Acquisition of writing skills

UNIT 5:

1. 'Our Living Environment' from English for Engineers and Technologists.

OBJECTIVE:

To highlight the fact that animals must be preserved beacuase animal life is precious.

OUTCOME:

The lesson creates an awareness in the reader as to the usefulness of animals for the human society.

2. 'A Village Host to Nation' from Panorama : A Course on Reading

OBJECTIVE:

To develop extensive reading skill and comprehension for pleasure and profit.

OUTCOME:

Acquisition of writing skills

UNIT 6:

1. ' Safety and Training' from English for Engineers and Technologists.

OBJECTIVE:

To highlight the possibility of accidents in laboratories, industries and other places and to follow safety measures.

OUTCOME:

The lesson helps in identifying safety measures against different varieties of accidents at home and in the workplace.

2. 'Martin Luther King and Africa' from Panorama : A Course on Reading

OBJECTIVE:

To develop extensive reading skill and comprehension for pleasure and profit.

OUTCOME:

Acquisition of writing skills

NOTE:

All the exercises given in the prescribed lessons in both detailed and non-detailed textbooks relating to the theme and language skills must be covered.

OVERALL COURSE OUTCOME:

1. Using English languages, both written and spoken, competently and correctly.
2. Improving comprehension and fluency of speech.
3. Gaining confidence in using English in verbal situations.

MODEL QUESTION PAPER FOR THEORY

PART- I

Six short answer questions on 6 unit themes

One question on eliciting student's response to any of the themes

PART-II

Each question should be from one unit and the last question can be a combination of two or more units.

Each question should have 3 sub questions: A,B & C

A will be from the main text: 5 marks

B from non-detailed text: 3 marks

C on grammar and Vocabulary: 6 marks

I Year - I Semester

L	T	P	C
4	0	0	3

MATHEMATICS-I
(Common to ALL branches of First Year B.Tech.)

Course Objectives:

1. The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2. The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.

Course Outcomes: At the end of the Course, Student will be able to:

1. Solve linear differential equations of first, second and higher order.
2. Determine Laplace transform and inverse Laplace transform of various functions and use Laplace transforms to determine general solution to linear ODE.
3. Calculate total derivative, Jocobian and minima of functions of two variables.

UNIT I: Differential equations of first order and first degree:
Linear-Bernoulli-Exact-Reducible to exact.
Applications: Newton's Law of cooling-Law of natural growth and decay-Orthogonal trajectories- Electrical circuits- Chemical reactions.

UNIT II: Linear differential equations of higher order:
Non-homogeneous equations of higher order with constant coefficients with RHS term of the type e^{ax}, sin ax, cos ax, polynomials in x, e^{ax} V(x), xV(x)- Method of Variation of parameters.
Applications: LCR circuit, Simple Harmonic motion.

UNIT III: Laplace transforms:
Laplace transforms of standard functions-Shifting theorems - Transforms of derivatives and integrals – Unit step function –Dirac's delta function- Inverse Laplace transforms– Convolution theorem (with out proof).
Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT IV: Partial differentiation:
Introduction- Homogeneous function-Euler's theorem-Total derivative-Chain rule-Generalized Mean value theorem for single variable (without proof)-Taylor's and Mc Laurent's series expansion of functions of two variables– Functional dependence- Jacobian.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT V: First order Partial differential equations:
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions –solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT VI: Higher order Partial differential equations:

Solutions of Linear Partial differential equations with constant coefficients. RHS term of the type $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$. Classification of second order partial differential equations.

Text Books:

1. **B.S.Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **N.P.Bali**, Engineering Mathematics, Lakshmi Publications.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India
2. **Micheael Greenberg,** Advanced Engineering Mathematics, 9th edition, Pearson edn
3. **Dean G. Duffy,** Advanced engineering mathematics with MATLAB, CRC Press
4. **Peter O'neil,** Advanced Engineering Mathematics, Cengage Learning.
5. **Srimanta Pal, Subodh C.Bhunia**, Engineering Mathematics, Oxford University Press.
6. **Dass H.K., Rajnish Verma. Er.,** Higher Engineering Mathematics, S. Chand Co. Pvt. Ltd, Delhi.

I Year - I Semester

L	T	P	C
4	0	0	3

APPLIED CHEMISTRY
(EEE, ECE, CSE, IT, EIE, E. Com. E.)

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Learning Objectives:

- Plastics are nowadays used in household appliances; also they are used as composites (FRP) in aerospace industries.
- Fuels as a source of energy are a basic need of any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence they are introduced.
- The basics for the construction of galvanic cells as well as some of the sensors used in instruments are introduced. Also if corrosion is to be controlled, one has to understand the mechanism of corrosion which itself is explained by electrochemical theory.
- With the increase in demand, a wide variety of materials are coming up; some of them have excellent engineering properties and a few of these materials are introduced.
- Understanding of crystal structures will help to understand the conductivity, semiconductors and superconductors. Magnetic properties are also studied.
- With the increase in demand for power and also with depleting sources of fossil fuels, the demand for alternative sources of fuels is increasing. Some of the prospective fuel sources are introduced.

UNIT I: HIGH POLYMERS AND PLASTICS

Polymerisation : Introduction- Mechanism of polymerization - Stereo regular polymers – methods of polymerization (emulsion and suspension) -Physical and mechanical properties – Plastics as engineering materials : advantages and limitations – Thermoplastics and Thermosetting plastics – Compounding and fabrication (4/5 techniques)- Preparation, properties and applications of polyethene, PVC, Bakelite Teflon and polycarbonates

Elastomers – Natural rubber- compounding and vulcanization – Synthetic rubbers : Buna S, Buna N, Thiokol and polyurethanes – Applications of elastomers.

Composite materials & Fiber reinforced plastics – Biodegradable polymers – Conducting polymers.

UNIT II: FUEL TECHNOLOGY

Fuels:- Introduction – Classification – Calorific value - HCV and LCV – Dulong's formula – Bomb calorimeter – Numerical problems – Coal — Proximate and ultimate analysis – Significance of the analyses – Liquid fuels – Petroleum- Refining – Cracking – Synthetic petrol –Petrol knocking – Diesel knocking - Octane and Cetane ratings – Anti-knock agents – Power alcohol – Bio-diesel – Gaseous fuels – Natural gas. LPG and CNG – Combustion – Calculation of air for the combustion of a fuel – Flue gas analysis – Orsat apparatus – Numerical problems on combustion.

Explosives:- Introduction, classification, examples: RDX, TNT and ammonium nitrite - rocket fuels.

UNIT III: ELECTROCHEMICAL CELLS AND CORROSION

Galvanic cells - Reversible and irreversible cells – Single electrode potential – Electro chemical series and uses of this series- Standard electrodes (Hydrogen and Calomel electrodes) - Concentration Cells – Batteries: Dry Cell - Ni-Cd cells - Ni-Metal hydride cells - Li cells - Zinc – air cells.

Corrosion:- Definition – Theories of Corrosion (electrochemical) – Formation of galvanic cells by different metals, by concentration cells, by differential aeration and waterline corrosion – Passivity of metals – Pitting corrosion - Galvanic series – Factors which influence the rate of corrosion - Protection from corrosion – Design and material selection – Cathodic protection - Protective coatings: – Surface preparation – Metallic (cathodic and anodic) coatings - Methods of application on metals (Galvanizing, Tinning, Electroplating, Electroless plating)

UNIT IV: CHEMISTRY OF ADVANCED MATERIALS

Nano materials:- Introduction – Sol-gel method & chemical reduction method of preparation – Characterization by BET method and TEM methods - Carbon nano tubes and fullerenes: Types, preparation, properties and applications

Liquid crystals:- Introduction – Types – Applications

Superconductors :- Type-I & Type-2, properties &applications

Green synthesis:- Principles - 3or 4 methods of synthesis with examples – R_4M_4 principles

UNIT V: SOLID STATE CHEMISTRY

Types of solids - close packing of atoms and ions - BCC , FCC, structures of rock salt - cesium chloride- spinel - normal and inverse spinels,

Non-elemental ***semiconducting Materials***:- Stoichiometric, controlled valency & Chalcogen photo/semiconductors, Preparation of Semiconductors - Semiconductor Devices:- p-n junction diode as rectifier – junction transistor.

Insulators (electrical and electronic applications)

Magnetic materials:- Ferro and ferri magnetism. Hall effect and its applications.

UNIT VI: NON CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES

Solar Energy: - Introduction, application of solar energy, conversion of solar energy (Thermal

conversion & photo conversion) – photovoltaic cell: design, working and its importance

Non-conventional energy sources:

(i) Hydropower include setup a hydropower plant (schematic diagram)

(ii) Geothermal energy: Introduction-schematic diagram of a geothermal power plant

(iii) Tidal and wave power: Introduction- Design and working-movement of tides and their effect on sea level.

(iv) Ocean thermal energy: Introduction, closed-cycle, ocean thermal energy conversion (OTEC), open cycle OTEC, hybrid OTEC, schematic diagram and explanation.

(v) Biomass and biofuels

Fuel cells:- Introduction - cell representation, H_2-O_2 fuel cell: Design and working, advantages and limitations. Types of fuel cells: Alkaline fuel cell - methanol-oxygen - phosphoric acid fuel cells - molten carbonate fuel cells.

Outcomes: The advantages and limitations of plastic materials and their use in design would be understood. Fuels which are used commonly and their economics, advantages and limitations are discussed. Reasons for corrosion and some methods of corrosion control would be understood. The students would be now aware of materials like nano-materials and fullerenes and their uses. Similarly liquid crystals and superconductors are understood. The importance of green synthesis is well understood and how they are different from conventional methods is also explained. Conductance phenomenon is better understood. The students are exposed to some of the alternative fuels and their advantages and limitations.

Standard Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co.
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2015 edition.

Reference Books:

1. Engineering Chemistry of Wiley India Pvt. Ltd., Vairam and others, 2014 edition (second).
2. Engineering Chemistry by Prasanth Rath, Cengage Learning, 2015 edition.
3. A text book of engineering Chemistry by S. S. Dara; S. Chand & Co Ltd., Latest Edition
4. Applied Chemistry by H.D. Gesser, Springer Publishers
5. Text book of Nano-science and nanotechnology by B.S. Murthy, P. Shankar and others, University Press, IIM

I Year - I Semester

L	T	P	C
4	0	0	3

ENIGINEERING MECHANICS

Objectives: The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I

Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.

Introduction to Engg. Mechanics – Basic Concepts.

Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.

Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT II

Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle of forces.

Equilibrium of Systems of Forces: Free Body Diagrams, Equations of Equilibrium of Coplanar Systems, Spatial Systems for concurrent forces. Lamis Theorm, Graphical method for the equilibrium of coplanar forces, Converse of the law of Triangle of forces, converse of the law of polygon of forces condition of equilibrium, analysis of plane trusses.

UNIT – III

Objectives : The students are to be exposed to concepts of centre of gravity.

Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures

Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.

UNIT IV

Objective: The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.

Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia. **Mass Moment of Inertia:** Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

UNIT – V

Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.

Kinematics: Rectilinear and Curvelinear motions – Velocity and Acceleration – Motion of Rigid Body – Types and their Analysis in Planar Motion. **Kinetics:** Analysis as a Particle and Analysis as a Rigid Body in Translation – Central Force Motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies.

UNIT – VI

Objectives: The students are to be exposed to concepts of work, energy and particle motion

Work – Energy Method: Equations for Translation, Work-Energy Applications to Particle Motion, Connected System-Fixed Axis Rotation and Plane Motion. Impulse momentum method.

TEXT BOOKS :

1. Engg. Mechanics - S.Timoshenko & D.H.Young., 4th Edn - , Mc Graw Hill publications.

REFERENCES :

1. Engineering Mechanics statics and dynamics – R.C.Hibbeler, 11th Edn – Pearson Publ.
2. Engineering Mechanics, statics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.
3. Engineering Mechanics, statics and dynamics – I.H.Shames, – Pearson Publ.
4. Mechanics For Engineers, statics - F.P.Beer & E.R.Johnston – 5th Edn Mc Graw Hill Publ.
5. Mechanics For Engineers, dynamics - F.P.Beer & E.R.Johnston –5th Edn Mc Graw Hill Publ.
6. Theory & Problems of engineering mechanics, statics & dynamics – E.W.Nelson, C.L.Best & W.G. McLean, 5th Edn – Schaum's outline series - Mc Graw Hill Publ.
7. Singer's Engineering Mechanics: Statics And Dynamics, K. Vijay Kumar Reddy, J. Suresh Kumar, Bs Publications
8. Engineering Mechanics, Fedinand . L. Singer, Harper – Collins.
9. Engineering Mechanics statics and dynamics , A Nelson , Mc Graw Hill publications

I Year - I Semester

L	T	P	C
4	0	0	3

COMPUTER PROGRAMMING

Learning objectives:
Formulating algorithmic solutions to problems and implementing algorithms in C.

- Notion of Operation of a CPU, Notion of an algorithm and computational procedure, editing and executing programs in Linux.
- Understanding branching, iteration and data representation using arrays.
- Modular programming and recursive solution formulation.
- Understanding pointers and dynamic memory allocation.
- Understanding miscellaneous aspects of C.
- Comprehension of file operations.

UNIT-I:
History and Hardware - Computer Hardware, Bits and Bytes, Components, Programming Languages - Machine Language, Assembly Language, Low- and High-Level Languages, Procedural and Object-Oriented Languages, Application and System Software, The Development of C Algorithms The Software Development Process.

UNIT-II:
Introduction to C Programming- Identifiers, The main () Function, The printf () Function
Programming Style - Indentation, Comments, Data Types**,** Arithmetic Operations, Expression Types, Variables and Declarations, Negation, Operator Precedence and Associativity, Declaration Statements, Initialization.
Assignment - Implicit Type Conversions, Explicit Type Conversions (Casts), Assignment Variations, Mathematical Library Functions, Interactive Input, Formatted Output, Format Modifiers.

UNIT -III:
Control Flow-Relational Expressions - Logical Operators:
Selection: if-else Statement, nested if, examples, Multi-way selection: switch, else-if, examples.
Repetition: Basic Loop Structures, Pretest and Posttest Loops, Counter-Controlled and Condition-Controlled Loops, The while Statement, The for Statement, Nested Loops, The do-while Statement.

UNIT-IV

Modular Programming: Function and Parameter Declarations, Returning a Value, Functions with Empty Parameter Lists, Variable Scope, Variable Storage Class, Local Variable Storage Classes, Global Variable Storage Classes, Pass by Reference, Passing Addresses to a Function, Storing Addresses, Using Addresses, Declaring and Using Pointers, Passing Addresses to a Function.

Case Study: Swapping Values, Recursion - Mathematical Recursion, Recursion versus Iteration.

UNIT-V:

Arrays & Strings

Arrays: One-DimensionalArrays, Input and Output of Array Values, Array Initialization, Arrays as Function Arguments, Two-Dimensional Arrays, LargerDimensionalArrays-Matrices

Strings: String Fundamentals, String Input and Output, String Processing, Library Functions

UNIT-VI:

Pointers, Structures, Files

Pointers: Concept of a Pointer, Initialisation of pointer variables, pointers as function arguments, passing by address, Dangling memory, address arithmetic, character pointers and functions, pointers to pointers, Dynamic memory management functions, command line arguments.

Structures: Derived types,Structuresdeclaration, Initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self referential structures, unions, typedef, bit-fields.

Data Files: Declaring, Opening, and Closing File Streams, Reading from and Writing to Text Files, Random File Access

Outcomes:

- Understand the basic terminology used in computer programming
- Write, compile and debug programs in C language.
- Use different data types in a computer program.
- Design programs involving decision structures, loops and functions.
- Explain the difference between call by value and call by reference
- Understand the dynamics of memory by the use of pointers
- Use different data structures and create/update basic data files.

Text Books:

1. ANSI C Programming, Gary J. Bronson, Cengage Learning.
2. Programming in C, Bl Juneja Anita Seth, Cengage Learning.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.

Reference Books:

1. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
2. Programming with C, Bichkar, Universities Press.
3. Programming in C, ReemaThareja, OXFORD.
4. C by Example, Noel Kalicharan, Cambridge.

I Year - I Semester

L	T	P	C
4	0	0	3

ENVIRONMENTAL STUDIES

Course Learning Objectives:

The objectives of the course is to impart

- Overall understanding of the natural resources
- Basic understanding of the ecosystem and its diversity
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities
- An understanding of the environmental impact of developmental activities
- Awareness on the social issues, environmental legislation and global treaties

Course Outcomes:

The student should have knowledge on

- The natural resources and their importance for the sustenance of the life and recognize the need to conserve the natural resources
- The concepts of the ecosystem and its function in the environment. The need for protecting the producers and consumers in various ecosystems and their role in the food web
- The biodiversity of India and the threats to biodiversity, and conservation practices to protect the biodiversity
- Various attributes of the pollution and their impacts and measures to reduce or control the pollution along with waste management practices
- Social issues both rural and urban environment and the possible means to combat the challenges
- The environmental legislations of India and the first global initiatives towards sustainable development.
- About environmental assessment and the stages involved in EIA and the environmental audit.
- Self Sustaining Green Campus with Environment Friendly aspect of – Energy, Water and Wastewater reuse Plantation, Rain water Harvesting, Parking Curriculum.

Syllabus:

UNIT – I

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, Carbon Credits, acid rains, ozone layer depletion, population growth and explosion, effects. Role of information Technology in Environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids. - Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT – II

Natural Resources: Natural resources and associated problems

Forest resources – Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people

Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Sustainable mining of Granite, Literate, Coal, Sea and River sands.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources Vs Oil and Natural Gas Extraction.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT – III Biodiversity and its conservation:

Definition: genetic, species and ecosystem diversity- classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT – IV

Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V

Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act - Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

UNIT – VI

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

TEXT BOOKS:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

REFERENCE:

1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2014

I Year - I Semester

L	T	P	C
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APPLIED/ENGINEERING CHEMISTRY LABORATORY (*Common to all branches)*

1. Introduction to Chemistry laboratory – Molarity, Normality, Primary, secondary standard solutions, Volumetric titrations, Quantitative analysis, Qualitative analysis, etc.
2. Trial experiment - Determination of HCl using standard Na_2CO_3 solution.
3. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
4. Determination of $KMnO_4$ using standard Oxalic acid solution.
5. Determination of Ferrous iron using standard $K_2Cr_2O_7$ solution.
6. Determination of Copper using standard $K_2Cr_2O_7$ solution.
7. Determination of temporary and permanent hardness of water using standard EDTA solution.
8. Determination of Copper using standard EDTA solution.
9. Determination of Iron by a Colorimetric method using thiocynate as reagent.
10. Determination of pH of the given sample solution using pH meter.
11. Conductometric titration between strong acid and strong base.
12. Conductometric titration between strong acid and weak base.
13. Potentiometric titration between strong acid and strong base.
14. Potentiometric titration between strong acid and weak base.
15. Determination of Zinc using standard EDTA solution.
16. Determination of Vitamin – C.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.
2. Dr. Jyotsna Cherukuris (2012) *Laboratory Manual of engineering chemistry-II,* VGS Techno Series
3. Chemistry Practical Manual, Lorven Publications
4. K. Mukkanti (2009) *Practical Engineering Chemistry,* B.S. Publication

I Year - I Semester

L	T	P	C
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ENGLISH - COMMUNICATION SKILLS LAB- I

PRESCRIBED LAB MANUAL FOR SEMESTER I:

'INTERACT: English Lab Manual for Undergraduate Students' Published by **Orient Blackswan Pvt Ltd.**

OBJECTIVES:

To enable the students to learn through practice the communication skills of listening, speaking, reading and writing.

OUTCOME:

A study of the communicative items in the laboratory will help the students become successful in the competitive world.

The course content along with the study material is divided into six units.

UNIT 1:

1. WHY study Spoken English?
2. Making Inqueries on the phone, thanking and responding to Thanks
   Practice work.

UNIT 2:

1. Responding to Requests and asking for Directions
   Practice work.

UNIT 3:

1. Asking for Clarifications, Inviting, Expressing Sympathy, Congratulating
2. Apologising, Advising, Suggesting, Agreeing and Disagreeing
   Practice work.

UNIT 4:

1. Letters and Sounds
   Practice work.

UNIT 5:

1. The Sounds of English
   Practice work.

UNIT 6:

1. Pronunciation
2. Stress and Intonation
   Practice work.

Assessment Procedure: Laboratory

1. Every lab session (150 minutes) should be handled by not less than two teachers (three would be ideal) where each faculty has to conduct a speaking activity for 20/30 students.
2. The teachers are to assess each learner in the class for not less than 10 speaking activities, each one to be assessed for 10 marks or 10%. The average of 10 day-to-day activity assessments is to be calculated for 10 marks for internal assessment.

The rubric given below has to be filled in for all the students for all activities.

The rubric to assess the learners:

	Body language		Fluency & Audibility	Clarity in Speech	Neutralization of accent	Appropriate Language		Total 10 marks	Remarks
	Gestures & Postures	Eye Contact				Grammar	Vocabulary & expressions		

- **Lab Assessment: Internal (25 marks)**
  1. Day-to-Day activities: 10 marks
  2. Completing the exercises in the lab manual: 5 marks
  3. Internal test (5 marks written and 5 marks oral)

- **Lab Assessment: External (50 marks)**
  1. Written test: 20 marks (writing a dialogue, note-taking and answering questions on listening to an audio recording.
  2. Oral: Reading aloud a text or a dialogue- 10 marks
  3. Viva-Voce by the external examiner: 20 marks

Reference Books:

1. Strengthen your communication skills by Dr M Hari Prasad, Dr Salivendra Raju and Dr G Suvarna Lakshmi, Maruti Publications.
2. English for Professionals by Prof Eliah, B.S Publications, Hyderabad.
3. Unlock, Listening and speaking skills 2, Cambridge University Press
4. Spring Board to Success, Orient BlackSwan
5. A Practical Course in effective english speaking skills, PHI
6. Word power made handy, Dr shalini verma, Schand Company
7. Let us hear them speak, Jayashree Mohanraj, Sage texts
8. Professional Communication, Aruna Koneru, Mc Grawhill Education
9. Cornerstone, Developing soft skills, Pearson Education

I Year - I Semester

L	T	P	C
0	0	3	2

COMPUTER PROGRAMMING LAB

OBJECTIVES:

- Understand the basic concept of C Programming, and its different modules that includes conditional and looping expressions, Arrays, Strings, Functions, Pointers, Structures and File programming.

- Acquire knowledge about the basic concept of writing a program.

- Role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language.

- Use of conditional expressions and looping statements to solve problems associated with conditions and repetitions.

- Role of Functions involving the idea of modularity.

Programming

Exercise - 1 Basics
a) What is an OS Command, Familiarization of Editors - vi, Emacs
b) Using commands like mkdir, ls, cp, mv, cat, pwd, and man
c) C Program to Perform Adding, Subtraction, Multiplication and Division of two numbers From Command line

Exercise - 2 Basic Math
a) Write a C Program to Simulate 3 Laws at Motion
b) Write a C Program to convert Celsius to Fahrenheit and vice versa

Exercise - 3 Control Flow - I
a)Write a C Program to Find Whether the Given Year is a Leap Year or not.
b)Write a C Program to Add Digits & Multiplication of a number

Exercise – 4 Control Flow - II
a)Write a C Program to Find Whether the Given Number is
i) Prime Number
ii) Armstrong Number
b) Write a C program to print Floyd Triangle
c) Write a C Program to print Pascal Triangle

Exercise – 5 Functions

a) Write a C Program demonstrating of parameter passing in Functions and returning values.
b) Write a C Program illustrating Fibonacci, Factorial with Recursion without Recursion

Exercise – 6 Control Flow - III

a) Write a C Program to make a simple Calculator to Add, Subtract, Multiply or Divide Using switch…case

b) Write a C Program to convert decimal to binary and hex (using switch call function the function)

Exercise – 7 Functions - Continued

Write a C Program to compute the values ofsin x and cos x and e^x values using Series expansion. (use factorial function)

Exercise – 8 Arrays

Demonstration of arrays

a) Search-Linear.
b) Sorting-Bubble, Selection.
c) Operations on Matrix.

Exercises - 9 Structures

a)Write a C Program to Store Information of a Movie Using Structure

b)Write a C Program to Store Information Using Structures with Dynamically Memory Allocation

c) Write a C Program to Add Two Complex Numbers by Passing Structure to a Function

Exercise - 10 Arrays and Pointers

a)Write a C Program to Access Elements of an Array Using Pointer

b) Write a C Program to find the sum of numbers with arrays and pointers.

Exercise – 11 Dynamic Memory Allocations

a) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc () function.

b) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

Understand the difference between the above two programs

Exercise – 12 Strings

a) Implementation of string manipulation operations **with** library function.
   i) copy
   ii) concatenate
   iii) length
   iv) compare

b) Implementation of string manipulation operations **without** library function.
   i) copy
   ii) concatenate
   iii) length
   iv) compare

Exercise -13 Files
a)Write a C programming code to open a file and to print it contents on screen.
b)Write a C program to copy files

Exercise - 14 Files Continued
a) Write a C program merges two files and stores their contents in another file.
b) Write a C program to delete a file.

OUTCOMES:

- Apply and practice logical ability to solve the problems.

- Understand C programming development environment, compiling, debugging, and linking and executing a program using the development environment

- Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs

- Understand and apply the in-built functions and customized functions for solving the problems.

- Understand and apply the pointers, memory allocation techniques and use of files for dealing with variety of problems.

- Document and present the algorithms, flowcharts and programs in form of user-manuals

- Identification of various computer components, Installation of software

Note:
a) All the Programs must be executed in the Linux Environment. (Mandatory)
b) The Lab record must be a print of the LATEX (.tex) Format.

I Year - II Semester

L	T	P	C
4	0	0	3

ENGLISH -II

Introduction:

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training the students to acquire communicative competence, the syllabus has been designed to develop linguistic and communicative competence of the students of Engineering.

As far as the detailed Textbooks are concerned, the focus should be on the skills of listening, speaking, reading and writing. The nondetailed Textbooks are meant for extensive reading for pleasure and profit.

Thus the stress in the syllabus in primarily on the development of communicative skills and fostering of ideas.

Objectives:

1. To imporve the language proficiency of the students in English with emphasis on LSRW skills.
2. To enable the students to study and comprehend the prescribed lessons and subjects more effectively relating to their theorotical and practical components.
3. To develop the communication skills of the students in both formal and informal situations.

LISTENING SKILLS:

Objectives:

1. To enable the students to appreciate the role of listening skill and improve their pronounciation.
2. To enable the students to comprehend the speech of people belonging to different backgrounds and regions.
3. To enable the students to listen for general content, to fill up information and for specific information.

SPEAKING SKILLS:

Objectives:

1. To make the students aware of the importance of speaking for their personal and professional communication.
2. To enable the students to express themselves fluently and accurately in social and professional success.
3. To help the students describe objects, situations and people.
4. To make the students participate in group activities like roleplays, discussions and debates.
5. To make the students particiapte in Just a Minute talks.

READING SKILLS:

Objectives:

1. To enable the students to comprehend a text through silent reading.
2. To enable the students to guess the meanings of words, messages and inferences of texts in given contexts.
3. To enable the students to skim and scan a text.
4. To enable the students to identify the topic sentence.
5. To enable the students to identify discourse features.
6. To enable the students to make intensive and extensive reading.

WRITING SKILLS:

Objectives:

1. To make the students understand that writing is an exact formal skills.
2. To enable the students to write sentences and paragraphs.
3. To make the students identify and use appropriate vocabulary.
4. To enable the students to narrate and describe.
5. To enable the students capable of note-making.
6. To enable the students to write coherently and cohesively.
7. To make the students to write formal and informal letters.
8. To enable the students to describe graphs using expressions of comparision.
9. To enable the students to write techincal reports.

Methodology:

1. The class are to be learner-centered where the learners are to read the texts to get a comprehensive idea of those texts on their own with the help of the peer group and the teacher.
2. Integrated skill development methodology has to be adopted with focus on individual language skills as per the tasks/exercise.
3. The tasks/exercises at the end of each unit should be completed by the learners only and the teacher interventionis perimitted as per the complexity of the task/exercise.
4. The teacher is expected to use supplementary material wherever necessary and also generate activities/tasks as per the requirement.
5. The teacher is perimitted to use lecture method when a completely new concept is introduced in the class.

Assessment Procedure: Theory

1. The formative and summative assessment procedures are to be adopted (mid exams and end semester examination).
2. Neither the formative nor summative assessment procedures should test the memory of the content of the texts given in the textbook. The themes and global comprehension of the units in the present day context with application of the langauge skills learnt in the unit are to be tested.
3. Only new unseen passages are to be given to test reading skills of the learners. Written skills are to be tested from sentence level to essay level. The communication formats—emails,letters and reports-- are to be tested along with appropriate langauge and expressions.
4. Examinations:

I mid exam + II mid exam (15% for descriptive tests+10% for online tests)= 25%

(80% for the best of two and 20% for the other)

Assignments= 5%

End semester exams=70%

5. Three take home assignments are to be given to the learners where they will have to read texts from the reference books list or other sources and write their gist in their own words.

The following text books are recommended for study in I B.Tech II Semester (Common for all branches)and I B.Pharma II Sem of JNTU Kakinada from the academic year 2016-17 **(R-16 Regulations)**

DETAILED TEXTBOOK: ENGLISH ENCOUNTERS Published by **Maruthi Publishers**.

DETAILED NON-DETAIL:THE GREAT INDIAN SCIENTISTS Published by **Cenguage learning**

The course content along with the study material is divided into six units.

UNIT 1:

1. ' The Greatest Resource- Education' from English Encounters

OBJECTIVE:

Schumacher describes the education system by saying that it was mere training, something more than mere knowledge of facts.

OUTCOME:

The lesson underscores that the ultimate aim of Education is to enhance wisdom.

2. ' A P J Abdul Kalam' from The Great Indian Scientists.

OBJECTIVE:

The lesson highlights Abdul Kalam's contributions to Indian science and the awards he received.

OUTCOME:

Abdul Kalam's simple life and service to the nation inspires the readers to follow in his footsteps.

UNIT 2:

1. ' A Dilemma' from English Encounters

OBJECTIVE: The lesson centres on the pros and cons of the development of science and technology.

OUTCOME: The lesson enables the students to promote peaceful co-existence and universal harmony among people and society.

2. 'C V Raman' from The Great Indian Scientists.

OBJECTIVE:

The lesson highlights the dedicated research work of C V Raman and his achievements in Physics.

OUTCOME:
The Achievements of C V Raman are inspiring and exemplary to the readers and all scientists.

UNIT 3:
1. 'Cultural Shock': Adjustments to new Cultural Environments from English Encounters.
OBJECTIVE:
The lesson depicts of the symptoms of Cultural Shock and the aftermath consequences.
OUTCOME:
The lesson imparts the students to manage different cultural shocks due to globalization.
2. 'Homi Jehangir Bhabha' from The Great Indian Scientists.
OBJECTIVE:
The lesson highlights Homi Jehangir Bhabha's contributions to Indian nuclear programme as architect.
OUTCOME:
The seminal contributions of Homi Jehangir Bhabha to Indian nuclear programme provide an aspiration to the readers to serve the nation and sterngthen it.

UNIT 4:
1. 'The Lottery' from English Encounters.
OBJECTIVE:
The lesson highlights insightful commentary on cultural traditions.
OUTCOME:
The theme projects society’s need to re examine its traditions when they are outdated.
2. 'Jagadish Chandra Bose' from The Great Indian Scientists.
OBJECTIVE:
The lesson gives an account of the unique discoveries and inventions of Jagadish Chandra Bose in Science.
OUTCOME: The Scientific discoveries and inventions of Jagadish Chandra Bose provide inspiration to the readers to make their own contributions to science and technology, and strengthen the nation.

UNIT 5:
1. ' The Health Threats of Climate Change' from English Encounters.
OBJECTIVE:
The essay presents several health disorders that spring out due to environmental changes
OUTCOME:
The lesson offers several inputs to protect environment for the sustainability of the future generations.
2. ' Prafulla Chandra Ray' from The Great Indian Scientists.
OBJECTIVE:
The lesson given an account of the experiments and discoveries in Pharmaceuticals of Prafulla Chandra Ray.
OUTCOME:
Prafulla Chandra Ray's scientific achievements and patriotic fervour provide inspiration to the reader.

UNIT 6:

1. ' The Chief Software Architect' from English Encounters

OBJECTIVE:

The lesson supports the developments of technology for the betterment of human life.

OUTCOME:

Pupil get inspired by eminent personalities who toiled for the present day advancement of software development.

2. ' Srinivasa Ramanujan' from The Great Indian Scientists.

OBJECTIVE:

The lesson highlights the extraordinary achievements of Srinivasa Ramanujan, a great mathematician and the most romantic figure in mathematics.

OUTCOME:

The lesson provides inspiration to the readers to think and tap their innate talents.

NOTE:

All the exercises given in the prescribed lessons in both detailed and non-detailed textbooks relating to the theme and language skills must be covered

.

MODEL QUESTION PAPER FOR THEORY

PART- I

Six short answer questions on 6 unit themes

One question on eliciting student's response to any of the themes

PART-II

Each question should be from one unit and the last question can be a combination of two or more units.

Each question should have 3 sub questions: A,B & C

A will be from the main text: 5 marks

B from non-detailed text: 3 marks

C on grammar and Vocabulary: 6 marks

I Year - II Semester

L	T	P	C
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MATHEMATICS-II (Mathematical Methods)

Course Objectives:

1. The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2. The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.
3. Understand the most basic numerical methods to solve simultaneous linear equations.

Course Outcomes: At the end of the Course, Student will be able to:

1. Calculate a root of algebraic and transcendental equations. Explain relation between the finite difference operators.
2. Compute interpolating polynomial for the given data.
3. Solve ordinary differential equations numerically using Euler's and RK method.
4. Find Fourier series and Fourier transforms for certain functions.
5. Identify/classify and solve the different types of partial differential equations.

UNIT I: Solution of Algebraic and Transcendental Equations:
Introduction- Bisection method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations).

UNIT II: Interpolation:
Introduction- Errors in polynomial interpolation – Finite differences- Forward differences-Backward differences –Central differences – Symbolic relations and separation of symbols - Differences of a polynomial-Newton's formulae for interpolation – Interpolation with unequal intervals - Lagrange's interpolation formula.

UNIT III: Numerical Integration and solution of Ordinary Differential equations:
Trapezoidal rule- Simpson's $1/3^{rd}$ and $3/8^{th}$ rule-Solution of ordinary differential equations by Taylor's series-Picard's method of successive approximations-Euler's method - Runge-Kutta method (second and fourth order).

UNIT IV: Fourier Series:
Introduction- Periodic functions – Fourier series of -periodic function - Dirichlet's conditions – Even and odd functions –Change of interval– Half-range sine and cosine series.

UNIT V: Applications of PDE:
Method of separation of Variables- Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

UNIT VI: Fourier Transforms:
Fourier integral theorem (without proof) – Fourier sine and cosine integrals - sine and cosine transforms – properties – inverse transforms – Finite Fourier transforms.

Text Books:

1. **B.S.Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **N.P.Bali**, Engineering Mathematics, Lakshmi Publications.

Reference Books:

1. **Dean G. Duffy,** Advanced engineering mathematics with MATLAB, CRC Press
2. **V.Ravindranath and P.Vijayalakshmi,** Mathematical Methods, Himalaya Publishing House.
3. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India
4. **David Kincaid, Ward Cheney**, Numerical Analysis-Mathematics of Scientific Computing, 3rd Edition, Universities Press.
5. **Srimanta Pal, Subodh C.Bhunia**, Engineering Mathematics, Oxford University Press.
6. **Dass H.K., Rajnish Verma. Er.,** Higher Engineering Mathematics, S. Chand Co. Pvt. Ltd, Delhi.

I Year - II Semester

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MATHEMATICS-III

Course Objectives:

1. The course is designed to equip the students with the necessary mathematical skills and techniques that are essential for an engineering course.
2. The skills derived from the course will help the student from a necessary base to develop analytic and design concepts.
3. Understand the most basic numerical methods to solve simultaneous linear equations.

Course Outcomes: At the end of the Course, Student will be able to:

1. Determine rank, Eigenvalues and Eigen vectors of a given matrix and solve simultaneous linear equations.
2. Solve simultaneous linear equations numerically using various matrix methods.
3. Determine double integral over a region and triple integral over a volume.
4. Calculate gradient of a scalar function, divergence and curl of a vector function. Determine line, surface and volume integrals. Apply Green, Stokes and Gauss divergence theorems to calculate line, surface and volume integrals.

UNIT I: Linear systems of equations:

Rank-Echelon form-Normal form – Solution of linear systems – Gauss elimination - Gauss Jordon- Gauss Jacobi and Gauss Seidal methods.Applications: Finding the current in electrical circuits.

UNIT II: Eigen values - Eigen vectors and Quadratic forms:

Eigen values - Eigen vectors– Properties – Cayley-Hamilton theorem - Inverse and powers of a matrix by using Cayley-Hamilton theorem- Diagonalization- Quadratic forms- Reduction of quadratic form to canonical form – Rank - Positive, negative and semi definite - Index – Signature.

Applications: Free vibration of a two-mass system.

UNIT III: Multiple integrals:

Curve tracing: Cartesian, Polar and Parametric forms.

Multiple integrals: Double and triple integrals – Change of variables – Change of order of integration.

Applications: Finding Areas and Volumes.

UNIT IV: Special functions:

Beta and Gamma functions- Properties - Relation between Beta and Gamma functions- Evaluation of improper integrals.

Applications: Evaluation of integrals.

UNIT V: Vector Differentiation:

Gradient- Divergence- Curl - Laplacian and second order operators -Vector identities.

Applications: Equation of continuity, potential surfaces

UNIT VI: Vector Integration:

ine integral – Work done – Potential function – Area- Surface and volume integrals Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and related problems.

Applications: Work done, Force.

Text Books:

1. **B.S.Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **N.P.Bali**, Engineering Mathematics, Lakshmi Publications.

Reference Books:

1. **Greenberg,** Advanced Engineering Mathematics, 2nd edition, Pearson edn
2. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India
3. **Peter O'Neil,** Advanced Engineering Mathematics,7th edition, Cengage Learning.
4. **D.W. Jordan and T.Smith,** Mathematical Techniques, Oxford University Press.
5. **Srimanta Pal, Subodh C.Bhunia**, Engineering Mathematics, Oxford University Press.
6. **Dass H.K., Rajnish Verma. Er.,** Higher Engineering Mathematics, S. Chand Co. Pvt. Ltd, Delhi.

I Year - II Semester

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APPLIED PHYSICS
(CSE, ECE, EEE, IT, EIE, E.Com.E)

OBJECTIVES: *Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by JNTUniv.Kkd. that serves as a transit to understand the branch specific advanced topics. The courses are designed to:*

- *Impart Knowledge of Physical Optics phenomena like Interference, Diffraction and Polarization involving required to design instruments with higher resolution.*
- *Teach Concepts of coherent sources, its realization and utility optical instrumentation.*
- *Study the concepts regarding the bulk response of materials to the EM fields and their analytically study in the back-drop of basic quantum mechanics.*
- *Understand the physics of Semiconductors and their working mechanism for their utility in sensors.*

UNIT-I

INTERFERENCE: Principle of Superposition – Coherent Sources – Interference in thin films (reflection geometry) – Newton's rings – construction and basic principle of Interferometers.

UNIT-II

DIFFRACTION: Fraunhofer diffraction at single slit - Cases of double slit, N-slits & Circular Aperture (Qualitative treatment only)-Grating equation - Resolving power of a grating, Telescope and Microscopes.

UNIT-III

POLARIZATION: Types of Polarization – Methods of production - Nicol Prism -Quarter wave plate and Half Wave plate – Working principle of Polarimeter (Sacharimeter).

LASERS: Characteristics– Stimulated emission – Einstein's Transition Probabilities-Pumping schemes - Ruby laser – Helium Neon laser.

UNIT-IV

ELECTROMAGNETIC FIELDS: Scalar and Vector Fields – Electric Potential- Gradient, Divergence of fields – Gauss and Stokes theorems-Propagation of EM waves through dielectric medium.

UNIT-V

QUANTUM MECHANICS: Introduction - Matter waves – Schröedinger Time Independent and Time Dependent wave equations – Particle in a box.
FREE ELECTRON THEORY: Defects of Classical free electron theory –Quantum Free electron theory - concept of Fermi Energy.

UNIT-VI

BAND THEORY OF SOLIDS: Bloch's theorem (qualitative) – Kronig – Penney model – energy bands in crystalline solids – classification of crystalline solids– effective mass of electron & concept of hole.

SEMICONDUCTOR PHYSICS: Conduction – Density of carriers in Intrinsic and Extrinsic semiconductors – Drift & Diffusion – relevance of Einstein's equation- Hall effect in semiconductors

***Outcome**: Construction and working details of instruments, ie., Interferometer, Diffractometer and Polarimeter are learnt. Study EM-fields and semiconductors under the concepts of Quantum mechanics paves way for their optimal utility.*

List of Text Books:

1. A Text book of Engineering Physics – by Dr. M.N.Avadhanulu and Dr.P.G.Kshira sagar, S.Chand & Company Ltd., (2014)
2. 'Solid State Physics' by A.J.Dekker, Mc Millan Publishers (2011)
3. Engineering Physics by D.K.Bhattacharya and Poonam Tandon, Oxford press (2015)

List of Reference Books:

1. Applied Physics by P.K.Palanisamy, Scitech publications (2014)
2. Lasers and Non-Linear optics by B.B.Laud, New Age International Publishers (2008).
3. Engineering Physics by M. Arumugam, Anuradha Publication (2014)

I Year - II Semester

L	T	P	C
4	0	0	3

ELECTRICAL CIRCUIT ANALYSIS – I

Preamble:
This course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the basic analysis of circuits which includes single phase circuits, magnetic circuits, network theorems, transient analysis and network topology.

Learning Objectives:

- To study the concepts of passive elements, types of sources and various network reduction techniques.
- To understand the applications of network topology to electrical circuits.
- To study the concept of magnetic coupled circuit.
- To understand the behaviour of RLC networks for sinusoidal excitations.
- To study the performance of R-L, R-C and R-L-C circuits with variation of one of the parameters and to understand the concept of resonance.
- To understand the applications of network theorems for analysis of electrical networks.

UNIT-I
Introduction to Electrical Circuits
Passive components and their V-I relations. Sources (dependent and independent) -Kirchoff's laws, Network reduction techniques(series, parallel, series - parallel, star-to-delta and delta-to-star transformation). source transformation technique, nodal analysis and mesh analysis.

UNIT-II
Network topology
Definitions of Graph and Tree, Basiccutset and tieset matrices for planar networks, Loop and nodal methods of analysis of networks with dependent and independent voltage and current sources, Duality and Dual networks.

UNIT-III
Magnetic Circuit
Basic definition of MMF, flux and reluctance. Analogy between electrical and magnetic circuits.Faraday's laws of electromagnetic induction Concept of self and mutual inductance.
Dot convention-coefficient of coupling and composite magnetic circuit.Analysis of series and parallel magnetic circuits.

UNIT-IV
Single Phase A.C Systems
Periodic waveforms (determination of rms, average value and form factor).Concept of phase angle and phase difference – Waveforms and phasor diagrams for lagging, leading networks.
Complex and polar forms of representations, steady state analysis of R, L and C circuits.
Power Factor and its significance real, reactive power and apparent power, waveform of instantaneous power triangle and complex power

UNIT-V

Analysis of AC Networks

Extension of node and mesh analysis to AC networks, Numerical problems on sinusoidal steady state analysis, Series and parallel resonance, Selectively band width and Quasi factor, Introduction to locus diagram.

UNIT-VI

Network theorems (DC & AC Excitations)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

Learning Outcomes:

Students are able to solve

- Various electrical networks in presence of active and passive elements.
- Electrical networks with network topology concepts.
- Any magnetic circuit with various dot conventions.
- Any R, L, C network with sinusoidal excitation.
- Any R, L, network with variation of any one of the parameters i.e R, L, C. and f.
- Electrical networks by using principles of network theorems.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,McGraw Hill Company,6 th edition
2. Network Analysis: Van Valkenburg; Prentice-Hall of India Private Ltd

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India)
2. Linear Circuit Analysis by De Carlo, Lin, Oxford publications
3. Electric Circuits– (Schaum's outlines) by MahmoodNahvi& Joseph Edminister, Adapted by KumaRao, 5th Edition – McGraw Hill.
4. Electric Circuits by David A. Bell, Oxford publications
5. Introductory Circuit Analysis by Robert L Boylestad, Pearson Publications
6. Circuit Theory(Analysis and Synthesis) by A.Chakrabarthi,DhanpatRai&Co.

I Year - II Semester

L	T	P	C
4	0	0	3

ENGINEERING DRAWING

Objective: Engineering drawing being the principle method of communication for engineers, the objective to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

- To introduce the use and the application of drawing instruments and to make the students construct the polygons, curves and various types of scales. The student will be able to understand the need to enlarge or reduce the size of objects in representing them.
- To introduce orthographic projections and to project the points and lines parallel to one plane and inclined to other.
- To make the students draw the projections of the lines inclined to both the planes.
- To make the students draw the projections of the plane inclined to both the planes.
- To make the students draw the projections of the various types of solids in different positions inclined to one of the planes.
- To represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

UNIT I Polygons, Construction of regular polygons using given length of a side; Ellipse, arcs of circles and Oblong methods; Scales – Vernier and Diagonal scales.

UNIT II Introduction to orthographic projections; projections of points; projections of straight lines parallel to both the planes; projections of straight lines – parallel to one plane and inclined to the other plane.

UNIT III Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclinations and traces.

UNIT IV Projections of planes: regular planes perpendicular/parallel to one plane and inclined to the other reference plane; inclined to both the reference planes.

UNIT V Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to one of the planes.

UNIT VI Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

TEXT BOOKS:

1. Engineering Drawing, N. D. Butt, Chariot Publications
2. Engineering Drawing, K. L. Narayana & P. Kannaiah, Scitech Publishers.
3. Engineering Graphics, P.I. Varghese, McGraw Hill Publishers

REFERENCE BOOKS:

1. Engineering Graphics for Degree, K. C. John, PHI Publishers
2. Engineering Drawing, Agarwal & Agarwal, Tata McGraw Hill Publishers
3. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

I Year - II Semester

L	T	P	C
0	0	3	2

ENGLISH LANGUAGE COMMUNICATION SKILLS LAB- II

PRESCRIBED LAB MANUAL FOR SEMESTER II:
'INTERACT: English Lab Manual for Undergraduate Students' Published by **Orient Blackswan Pvt Ltd.**

OBJECTIVES:

To enable the students to learn demonstratively the communication skills of listening, speaking, reading and writing.

OUTCOME:

A study of the communicative items in the laboratory will help the students become successful in the competitive world.

The course content along with the study material is divided into six units.

UNIT 1:

1. Debating
   Practice work

UNIT 2:

1. Group Discussions
   Practice work

UNIT 3:

1. Presentation Skills
   Practice work

UNIT 4:

1. Interview Skills
   Practice work

UNIT 5:

1. Email,
2. Curriculum Vitae
   Practice work

UNIT 6:

1. Idiomatic Expressions
2. Common Errors in English
   Practice work

Reference Books:

1. Strengthen your communication skills by Dr M Hari Prasad, Dr Salivendra Raju and Dr G Suvarna Lakshmi, Maruti Publications.
2. English for Professionals by Prof Eliah, B.S Publications, Hyderabad.
3. Unlock, Listening and speaking skills 2, Cambridge University Press
4. Spring Board to Success, Orient BlackSwan
5. A Practical Course in effective english speaking skills, PHI
6. Word power made handy, Dr shalini verma, Schand Company
7. Let us hear them speak, Jayashree Mohanraj, Sage texts
8. Professional Communication, Aruna Koneru, Mc Grawhill Education
9. Cornerstone, Developing soft skills, Pearson Education

I Year - II Semester

L	T	P	C
0	0	3	2

APPLIED/ENGINEERING PHYSICS LAB
(Any 10 of the following listed experiments)

Objective: *Training field oriented Engineering graduates to handle instruments and their design methods to improve the accuracy of measurements.*

LIST OF EXPERIMENTS:

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Determination of Rigidity modulus of a material- Torsional Pendulum.
5. Determination of Acceleration due to Gravity and Radius of Gyration- Compound Pendulum.
6. Melde's experiment – Transverse and Longitudinal modes.
7. Verification of laws of vibrations in stretched strings – Sonometer.
8. Determination of velocity of sound – Volume Resonator.
9. L- C- R Series Resonance Circuit.
10. Study of I/V Characteristics of Semiconductor diode.
11. I/V characteristics of Zener diode.
12. Characteristics of Thermistor – Temperature Coefficients.
13. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
14. Energy Band gap of a Semiconductor p - n junction.
15. Hall Effect in semiconductors.
16. Time constant of CR circuit.
17. Determination of wavelength of laser source using diffraction grating.
18. Determination of Young's modulus by method of single cantilever oscillations.
19. Determination of lattice constant – lattice dimensions kit.
20. Determination of Planck's constant using photocell.
21. Determination of surface tension of liquid by capillary rise method.

Outcome: *Physics lab curriculum gives fundamental understanding of design of an instrument with targeted accuracy for physical measurements.*

I Year - II Semester

L	T	P	C
0	0	2	0

APPLIED/ENGINEERING PHYSICS - VIRTUAL LABS – ASSIGNMENTS
(Constitutes 5% marks of 30marks of Internal-component)

Objective: *Training Engineering students to prepare a technical document and improving their writing skills.*

LIST OF EXPERIMENTS

1. Hall Effect
2. Crystal Structure
3. Hysteresis
4. Brewster's angle
5. Magnetic Levitation / SQUID
6. Numerical Aperture of Optical fiber
7. Photoelectric Effect
8. Simple Harmonic Motion
9. Damped Harmonic Motion
10. LASER – Beam Divergence and Spot size
11. B-H curve
12. Michelson's interferometer
13. Black body radiation

URL: ***www.vlab.co.in***

Outcome: *Physics Virtual laboratory curriculum in the form of assignment ensures an engineering graduate to prepare a /technical/mini-project/ experimental report with scientific temper.*

I Year - II Semester

L	T	P	C
0	0	3	2

ENGINEERING WORKSHOP & IT WORKSHOP

ENGINEERING WORKSHOP:

Course Objective: To impart hands-on practice on basic engineering trades and skills.

Note: At least two exercises to be done from each trade.

Trade:

Carpentry	1. T-Lap Joint
	2. Cross Lap Joint
	3. Dovetail Joint
	4. Mortise and Tennon Joint
Fitting	1. Vee Fit
	2. Square Fit
	3. Half Round Fit
	4. Dovetail Fit
Black Smithy	1. Round rod to Square
	2. S-Hook
	3. Round Rod to Flat Ring
	4. Round Rod to Square headed bolt
House Wiring	1. Parallel / Series Connection of three bulbs
	2. Stair Case wiring
	3. Florescent Lamp Fitting
	4. Measurement of Earth Resistance
Tin Smithy	1. Taper Tray
	2. Square Box without lid
	3. Open Scoop
	4. Funnel

IT WORKSHOP:

Objectives: Enabling the student to understand basic hardware and software tools through practical exposure

PC Hardware:

Identification of basic peripherals, assembling a PC, installation of system software like MS Windows, device drivers. Troubleshooting Hardware and software _ some tips and tricks.

Internet & World Wide Web:

Different ways of hooking the PC on to the internet from home and workplace and effectively usage of the internet, web browsers, email, newsgroups and discussion forums .Awareness of cyber hygiene(protecting the personal computer from getting infected with the viruses), worms and other cyber attacks .

Productivity tools Crafting professional word documents; excel spread sheets, power point presentations and personal web sites using the Microsoft suite of office tools

(Note: Student should be thoroughly exposed to minimum of 12 Tasks)

PC Hardware

Task 1:Identification of the peripherals of a computer.
To prepare a report containing the block diagram of the CPU along with the configuration of each peripheral and its functions. Description of various I/O Devices

Task 2(Optional): A practice on disassembling the components of a PC and assembling them to back to working condition.

Task 3: Examples of Operating systems- DOS, MS Windows,Installation of MS windows on a PC.

Task 4: Introduction to Memory and Storage Devices , I/O Port, Device Drivers, Assemblers, Compilers, Interpreters , Linkers, Loaders.

Task 5:
Hardware Troubleshooting (Demonstration):
Identification of a problem and fixing a defective PC (improper assembly or defective peripherals).
Software Troubleshooting (Demonstration):. Identification of a problem and fixing the PC for any software issues
Internet & Networking Infrastructure

Task 6: Demonstrating Importance of Networking, Transmission Media, Networking Devices- Gateway, Routers, Hub, Bridge, NIC ,Bluetooth Technology, Wireless Technology, Modem, DSL, Dialup Connection.
Orientation & Connectivity Boot Camp and web browsing: Students are trained to configure the network settings to connect to the Internet. They are trained to demonstrate the same through web browsing (including all tool bar options) and email access.

Task 7: **Search Engines & Netiquette:**
Students are enabled to use search engines for simple search, academic search and any other context based search (Bing, Google etc). Students are acquainted to the principles of micro-blogging, wiki, collaboration using social networks, participating in online technology forums

Task 8: Cyber Hygiene (Demonstration): Awareness of various threats on the internet. Importance of security patch updates and anti-virus solutions. Ethical Hacking, Firewalls, Multi-factor authentication techniques including Smartcard, Biometrics are also practiced
Word

Task 9: MS Word Orientation:
Accessing, overview of toolbars, saving files, Using help and resources, rulers, formatting ,Drop Cap , Applying Text effects, Using Character Spacing, OLE in Word, using templates, Borders and Colors, Inserting Header and Footer, Using Date and Time option, security features in word, converting documents while saving

Task 10: Creating project : Abstract Features to be covered:-Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check , Track Changes, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes and Paragraphs.

Excel

Task 11: Using spread sheet features of EXCEL including the macros, formulae, pivot tables, graphical representations
Creating a Scheduler - Features to be covered:- Gridlines, Format Cells, Summation, auto fill, Formatting Text
LOOKUP/VLOOKUP

Task 12: Performance Analysis - Features to be covered:- Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting
Power Point

Task 13: Students will be working on basic power point utilities and tools which help them create basic power point presentation. Topic covered during this week includes :- PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows, Hyperlinks, Inserting –Images, Clip Art, Tables and Charts in Powerpoint.

Task 14: Focusing on the power and potential of Microsoft power point. Helps them learn best practices in designing and preparing power point presentation. Topic covered during this week includes: - Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), Inserting – Background, textures, Design Templates, Hidden slides, OLE in PPT.

TEXT BOOK:

Faculty to consolidate the workshop manuals using the following references

1. Computer Fundamentals, Anita Goel, Pearson
2. Scott Mueller's Upgrading and Repairing PCs, 18/e, Scott. Mueller, QUE, Pearson,2008
3. Information Technology Workshop, 3e, G. Praveen Babu, M. V. Narayana BS Publications.
4. Comdex Information Technology , Vikas Gupta, dreamtech.

REFERENCE:

Essential Computer and IT Fundamentals for Engineering and Science Students, N. B. Venkateswarlu

II Year – ISEMESTER

L	T	P	C
4	0	0	3

ELECTRICAL CIRCUIT ANALYSIS-II

Preamble :
This course aims at study of three phase systems, transient analysis, network synthesis and fourier analysis for the future study and analysis of power systems.

Learning Objectives:

- To study the concepts of balancedand unbalanced three-phase circuits.
- To study the transient behaviour of electrical networks with DC, pulse and AC excitations.
- To study the performance of a network based on input and output excitation/response.
- To understand the realization of electrical network function into electrical equivalent passive elements.
- To understand the application of fourier series and fourier transforms for analysis of electrical circuits.

UNIT-I Balanced Three phase circuits
Phase sequence- star and delta connection - relation between line and phase voltages and currents - analysis of balanced three phase circuits - measurement of active and reactive power.

UNIT-II Unbalanced Three phase circuits
Analysis of three phase unbalanced circuits: Loop method – Star-Delta transformation technique, Two wattmeter methods for measurement of three phase power.

UNIT-III Transient Analysis in DC and AC circuits
Transient response of R-L, R-C, R-L-C circuits for DC and AC excitations, Solution using differential equations and Laplace transforms.

UNIT-IV Two Port Networks
Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, Cascaded networks - Poles and zeros of network functions.

UNIT-V Network synthesis
Positive real function - basic synthesis procedure - LC immittance functions - RC impedance functions and RL admittance function - RL impedance function and RC admittance function - Foster and Cauer methods.

UNIT-VI Fourier analysis and Transforms
Fourier theorem- Trigonometric form and exponential form of Fourier series, Conditions of symmetry- line spectra and phase angle spectra, Analysis of electrical circuits to non sinusoidal periodic waveforms.
Fourier integrals and Fourier transforms – properties of Fourier transforms physical significance of the Fourier Transform and its application to electrical circuits.

Learning Outcomes:

- Students are able to solve three- phase circuits under balanced and unbalanced condition
- Students are able find the transient response of electrical networks for different types of excitations.
- Students are able to find parameters for different types of network.
- Students are able to realize electrical equivalent network for a given network transfer function.
- Students are able to extract different harmonics components from the response of a electrical network.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,McGraw Hill Company,6 th edition
2. Network synthesis: Van Valkenburg; Prentice-Hall of India Private Ltd

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India)
2. Introduction to circuit analysis and design by TildonGlisson. Jr, Springer Publications.
3. Circuits by A.Bruce Carlson , Cengage Learning Publications
4. Network Theory Analysis and Synthesis by SmarajitGhosh, PHI publications
5. Networks and Systems by D. Roy Choudhury, New Age International publishers
6. Electric Circuits by David A. Bell, Oxford publications
7. Circuit Theory (Analysis and Synthesis) by A.Chakrabarthi,DhanpatRai&Co.

II Year – I SEMESTER

L	T	P	C
4	0	0	3

ELECTRICAL MACHINES – I

Preamble:
This is a basic course on rotating electrical machines. This course covers the topics related to principles, performance, applications and design considerations of dc machines and transformers.

Learning objectives:

- Understand the unifying principles of electromagnetic energy conversion.
- Understand the construction, principle of operation and performance of DC machines.
- Learn the characteristics, performance,methods of speed control and testing methods of DC motors.
- To predetermine the performance of single phase transformers with equivalent circuit models.
- Understand the methods of testing of single-phase transformer.
- Analyze the three phase transformers and achieve three phase to two phase conversion.

UNIT–I:
Electromechanical Energy Conversion and introduction to DC machines
Principles of electromechanical energy conversion – singly excited and multi excited system – Calculation of force and torque using the concept of co-energy.
Construction and principle of operation of DC machine – EMF equation for generator – Classification of DC machines based on excitation – OCC of DC shunt generator.

UNIT–II:
Performance of D.C. Machines
Torque and back-emf equations of dc motors– Armature reaction and commutation – characteristics of separately-excited, shunt, series and compound motors - losses and efficiency- applications of dc motors.

UNIT-III:
Starting, Speed Control and Testing of D.C. Machines
Necessity of starter – Starting by 3 point and 4 point starters – Speed control by armature voltage and field control – testing of DC machines - brake test, Swinburne's method – principle of regenerative or Hopkinson's method - retardation test -- separation of losses.

UNIT–IV:
Single-phase Transformers
Types and constructional details - principle of operation - emf equation - operation on no load and on load – lagging, leading and unity power factors loads - phasor diagrams of transformers – equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency.

UNIT-V

Single-phase Transformers Testing

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses – parallel operation with equal voltage ratios – auto transformer - equivalent circuit – comparison with two winding transformers.

UNIT-VI

3-Phase Transformers

Polyphase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ -- Third harmonics in phase voltages - three winding transformers: determination of Zp, Zs and Zt -- transients in switching - off load and on load tap changers -- Scott connection.

Learning outcomes:

- Able to assimilate the concepts of electromechanical energy conversion.
- Able to mitigate the ill-effects of armature reaction and improve commutation in dc machines.
- Able to understand the torque production mechanism and control the speed of dc motors.
- Able to analyze the performance of single phase transformers.
- Able to predetermine regulation, losses and efficiency of single phase transformers.
- Able to parallel transformers, control voltages with tap changing methods and achieve three-phase to two-phase transformation.

Text Books:

1. Electrical Machines – P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans, TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,McGrawHill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition.
3. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education 2015
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010
5. Electric Machines by MulukutlaS.Sarma&Mukeshk.Pathak, CENGAGE Learning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons

II Year – I SEMESTER

L	T	P	C
4	0	0	3

BASIC ELECTRONICS AND DEVICES

Preamble:

This course introduces the concepts of semi-conductor physics and operation of various semi-conductor devices. Realization of rectifiers, amplifiers and oscillators using semi-conductor devices and their analysis is also introduced in this course.

Unit-I:

Objective:

To learn the basics of semiconductor physics.

Review of Semi Conductor Physics: Insulators, Semi conductors, and Metals classification using Energy Band Diagrams, Mobility and Conductivity, Electrons and holes in Intrinsic Semi conductors, Extrinsic Semi Conductor, (P and N Type semiconductor) Hall effect, Generation and Recombination of Charges, Diffusion, Continuity Equation, Injected Minority Carriers, Law of Junction, Introduction to fermi level in Intrinsic, Extrinsic semi conductors with necessary mathematics

Outcome:

Students are able to understand the basic concepts of semiconductor physics, which are useful to understand the operation of diodes and transistors.

Unit-II:

Objective:

To study the construction details, operation and characteristics of various semiconductor diodes.

Junction Diode Characteristics

Operation and characteristics of p-n junction diode. Current components in p-n diode, diode equation. Temperature dependence on V–I characteristic, diffusion capacitance and diode resistance (static and dynamic), energy band diagram of p-n diode.

Special Diodes: Avalanche and Zener break down, Zener characteristics, tunnel diode, characteristics with the help of energy band diagrams, Varactor diode, LED, PIN diode, Photo diode

Outcome:

Students are able to explain the operation and characteristics of PN junction diode and special diodes.

Unit-III:

Objective:

To understand the operation and analysis of rectifiers with and without filters. Further study the operation of series and shunt regulators using zener diodes.

Rectifiers and Regulators

Half wave rectifier, ripple factor, full wave rectifier (with and without transformer), harmonic components in a rectifier circuit, inductor filter, capacitor filter, L-section filter, Π- section filter, and comparison of various filter circuits in terms of ripple factors. Simple circuit of a regulator using Zener diode. Types of regulators-series and shunt voltage regulators, over load voltage protection.

Outcome:
Ability to understand operation and design aspects of rectifiers and regulators.

Unit-IV:
Objective:
To study the characteristics of different bipolar junction transistors and their biasing stabilization and compensation techniques. To analyze transistor amplifiers using h-parameters.

Transistors
Junction transistor, transistor current components, transistor as an amplifier and switch. Characteristics of transistor (CE, CB and CC configurations). Transistor biasing and thermal stabilization (to fixed bias, collector to base bias, self bias). Compensation against variation in base emitter voltage and collector current. Thermal runaway. Hybrid model of transistor. Analysis of transistor amplifier using h-parameters

Outcome:
Students are able to understand the characteristics of various transistor configurations. They become familiar with different biasing, stabilization and compensation techniques used in transistor circuits.

Unit- V:
Objective:
To understand the basics of FET,Thyristors, Power IGBTs and Power MOSFETs.

Power semiconductor devices
Principle of operation and characteristics of Thyristors, Silicon control rectifiers, power IGBT and power MOSFET their ratings. Comparison of power devices.
FET: JFET Characteristics (Qualitative explanation), MOFET Characteristics–static and Transfer (enhancement and depletion mode), low frequency model of FET, FET as an amplifier.

Outcome:
Students are able to understand the operation and characteristics of FET, Thyristors, Power IGBTs and Power MOSFETs.

Unit VI :
Objective:
To understand the concepts of positive and negative feedbacks and their role in amplifiers and oscillators.

Amplifiers and oscillators
Feedback Amplifiers -classification, feedback concept, transfer gain and general characteristics of negative feedback amplifiers, effect of feedback on input and output resistances. Methods of analysis of feedback amplifiers.
Power Amplifiers – Classification, push-pull amplifiers, Introduction to harmonics (distortion factor.
Oscillators – Condition for oscillation, RC-phase shift oscillator. Wein bridge oscillator, Crystal oscillator. Frequency and amplitude stability of oscillators.

Outcome:
Students are able to understand the merits and demerits of positive and negative feedback and the role of feedback in oscillators and amplifiers.

TEXT BOOKS:

1. Electronic Devices and Circuits – J. Millman, C.C. Halkias, Tata Mc-Graw Hill

REFERENCE BOOKS:

1. Electronic Devices and Circuits by David A. Bell, Oxford University Press
2. Electronic Devices and Circuits – Salivahanan, Kumar, Vallavaraj, TATA McGraw Hill, Second Edition
3. Electronic Devices and Circuits – R.L. Boylestad and Louis Nashelsky, Pearson/Prentice Hall, 9thEdition, 2006

II Year – I SEMESTER

L	T	P	C
4	0	0	3

ELECTROMAGNETIC FIELDS

Preamble:

Electromagnetic fields are the pre-requisite for most of the subjects in the gamut of electrical engineering. The study of this subject enables students to understand and interpret the phenomenon pertinent to electrical engineering using microscopic quantities such as electric and magnetic field intensities, scalar and vector potentials.

Learning objectives:

- To study the production of electric field and potentials due to different configurations of static charges.
- To study the properties of conductors and dielectrics, calculate the capacitance of various configurations and understand the concept of conduction and convection current densities.
- To study the magnetic fields produced by currents in different configurations, application of ampere's law and the Maxwell's second and third equations.
- To study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other current loops.
- To develop the concept of self and mutual inductances and the energy stored.
- To study time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the induced e.m.f.

UNIT – I Electrostatics:

Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Guass's law — Maxwell's first law, div(D)=ρv Laplace's and Poison's equations and Solution of Laplace's equation in one variable.

UNIT – II Conductors – Dielectrics and Capacitance:

Electric dipole – Dipole moment – potential and EFI due to an electric dipole – Torque on an Electric dipole in an electric field – Behaviour of conductors in an electric field – Conductors and Insulators

Polarization – Boundary conditions between conduction to Dielectric and dielectric to dielectrics capacitance – capacitance of parallel plates, spherical and coaxial cables with composite dielectrics –Energy stored and energy density in a static electric field – Current density – conduction and Convection current densities – Ohm's law in point form – Equation of continuity

UNIT – III Magneto statics and Ampere's Law:

Static magnetic fields – Biot-Savart's law – Oesterd's experiment - Magnetic field intensity (MFI) – MFI due to a straight current carrying filament – MFI due to circular, square and solenoid current – Carrying wire – Relation between magnetic flux, magnetic flux density and MFI – Maxwell's second Equation, div(B)=0 –Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long filament carrying conductor – Point form of Ampere's circuital law –Field due to a circular loop, rectangular and square loops, Maxwell's third equation, Curl (H)=J.

UNIT – IV Force in Magnetic fields:
Magnetic force - Moving charges in a Magnetic field – Lorentz force equation – force on a current element in a magnetic field – Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors – Magnetic dipole and dipole moment – a differential current loop as a magnetic dipole – Torque on a current loop placed in a magnetic field.

UNIT – V Self and Mutual inductance:
Self and Mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT – VI Time Varying Fields:
Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms – Maxwell's fourth equation, Curl (E)=-∂B/∂t – Statically and Dynamically induced EMFs – Simple problems -Modification of Maxwell's equations for time varying fields – Displacement current – Poynting Theorem and Poynting vector.

Learning outcomes:
- To Determine electric fields and potentialsusing guass's lawor solving Laplace's or Possion's equations, for various electric charge distributions.
- To Calculate and design capacitance, energy stored in dielectrics.
- To Calculate the magnetic field intensity due to current, the application of ampere's law and the Maxwell's second and third equations.
- To determine the magnetic forces and torque produced by currents in magnetic field
- To determine self and mutual inductances and the energy stored in the magnetic field.
- To calculate induced e.m.f., understand the concepts of displacement current and Poynting vector.

Text Books:
1."Engineering Electromagnetics" by William H. Hayt& John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.

Reference Books:
1." Principles of Electro Magnetics" by Sadiku, Oxford Publications,4th edition
2."Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt.Ltd, 2nd edition
3."Electromagnetic Field Theory" by YaduvirSingh,Pearson.
4.Fundamentals of Engineering Electromagnetics by Sunil Bhooshan,Oxford higher Education.

II Year – I SEMESTER

L	T	P	C
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THERMAL AND HYDRO PRIME MOVERS

Part-A: Thermal prime movers

Course Objectives: To make the student understand the types of prime movers, which can be connected to generators for power production and should obtain the skills of performing the necessary calculations with respect to the functioning of the prime movers.

UNIT I:
Objectives: To make the student learn about the constructional features, operational details of various types of internal combustion engines through the details of several engine systems and the basic air standard cycles, that govern the engines. Further, the student shall be able to calculate the performance of different types of internal combustion engines.

I.C Engines: Classification, working principles – valve and port timing diagrams – air standard cycles – Engine systems line fuel injection, carburetion, ignition, cooling and lubrication – Engine performance evaluation.

UNIT II:
Objectives: To train the student in the aspects of steam formation and its utilities through the standard steam data tables and charts. To make the student correlate between the air standard cycles and the actual cycles that govern the steam turbines. To train the student to calculate the performance of steam turbines using velocity diagrams.

Properties of Steam and use of Steam Tables- T-S and H-S Diagrams. Analysis of Various Thermodynamic Processes under gone by Steam.
Vapor Power Cycles: Carnot Cycle-Rankine Cycle- Thermodynamic Variables Effecting Efficiency and output of Rankine Cycle-. Analysis of simple Rankine Cycle and Re-heat cycle
Steam Turbines: Schematic layout of steam power plant Classification of Steam Turbines- Impulse Turbine and Reaction Turbine- Compounding in Turbines- Velocity Diagrams for simple Impulse and Reaction Turbines- Work done & efficiency

UNIT III:
Objectives: To impart the knowledge of gas turbine fundamentals, the governing cycles and the methods to improve the efficiency of gas turbines.

Gas Turbines: Simple gas turbine plant-ideal cycle, closed cycle -open cycle-. Efficiency, Work ratio and optimum pressure ratio for simple gas turbine cycle. Actual cycle, analysis of simple cycles & cycles with inter cooling, reheating and Regeneration

Part-B: Hydro prime movers

UNIT IV:
Objectives: To teach the student about the fundamental of fluid dynamic equations and its applications fluid jets. To impart the knowledge of various types of pumps, their constructional features, working and performance.

IMPACT OF JETS AND PUMPS: Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved). Pumps: Types of pumps, Centrifugal pumps: Main components, Working principle, Multi stage pumps, Performance and characteristic curves

UNIT V:

Objectives: To make the student learn about the constructional features, operational details of various types of hydraulic turbines. Further, the student shall be able to calculate the performance of hydraulic turbines.

HYDRAULIC TURBINES: Classification of turbines; Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines; Governing of turbines; Performance and characteristic curves.

UNIT VI:

Objectives: To train the student in the areas of types of hydro electric power plants, estimation and calculation of different loads by considering various factors.

HYDRO POWER: Components of Hydro electric power plant: pumped storage systems, Estimation of water power potential; Estimation of load on turbines: load curve, load factor, capacity factor, utilization factor, diversity factor, load – duration curve, firm power, secondary power, prediction of load.

Text Books:

1. Thermal Engineering by Rajput, Lakshmi publications
2. Thermal engineering by M.L.Mathur and F.S.Mehta, Jain Brothers.
3. "Hydraulics & Fluid Mechanics", P.N. Modi and S.M. Seth, TEXT BOOKS House, Delhi
4. "Fluid Mechanics & Hydraulic Machinery" A.K.Jain, , Khanna Publishers, Delhi.

Reference Books:

1. "Fluid Mechanics" by Victor.L.Streeter
2. "Introduction to Fluid Mechanics" Edward .J. Shaughnessy Jr.
3. "Fluid Mechanics & Its Applications", Vijay Gupta, Santhosh.k.Gupta
4. "Fluid Mechanics & Fluid power Engineering, Dr D.S.Kumar
5. "Water Power Engineering" M.M Desumukh

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II Year - I Semester				
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MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS
(Common to all Branches)

Course Objectives:

- The Learning objectives of this paper is to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting, Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation. Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Production and Cost Analyses:

Concept of Production function- Cobb-Douglas Production function- Leontief production function - Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs- Fixed costs, Variable Costs and Total costs – Cost –Volume-Profit analysis-Determination of Breakeven point(simple problems)- Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing.

Unit – IV:

Types of Business Organization and Business Cycles:

Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms – Business Cycles : Meaning and Features – Phases of a Business Cycle.

Unit – V:

Introduction to Accounting & Financing Analysis:

Introduction to Double Entry Systems – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow statements (Simple Problems)

Unit – VI:

Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcome:

*The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product and the knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.

*One is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.

*The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis and to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

TEXT BOOKS

1. Dr. N. AppaRao, Dr. P. Vijay Kumar: 'Managerial Economics and Financial Analysis', Cengage Publications, New Delhi – 2011
2. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2011
3. Prof. J.V.Prabhakararao, Prof. P. Venkatarao. 'Managerial Economics and Financial Analysis', Ravindra Publication.

REFERENCES:

1.Dr. B. Kuberudu and Dr. T. V. Ramana: Managerial Economics & Financial Analysis, Himalaya Publishing House, 2014.
2. V. Maheswari: Managerial Economics, Sultan Chand.2014
3. Suma Damodaran: Managerial Economics, Oxford 2011.
4. VanithaAgarwal: Managerial Economics, Pearson Publications 2011.
5. Sanjay Dhameja: Financial Accounting for Managers, Pearson.
6. Maheswari: Financial Accounting, Vikas Publications.
7. S. A. Siddiqui& A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2012
8. Ramesh Singh, Indian Economy, 7th Edn., TMH2015
9. Pankaj Tandon A Text Book of Microeconomic Theory, Sage Publishers, 2015
10. Shailaja Gajjala and Usha Munipalle, Univerties press, 2015

II Year – I SEMESTER

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THERMAL AND HYDRO LAB

Course Objective: To impart practical knowledge on the performance evaluation methods of various internal combustion engines, flow measuring equipment and hydraulic turbines and pumps.

NOTE: TO CONDUCT A MINIMUM OF 12 EXPERIMENTS BY CONDUCTING A MINIMUM OF SIX FROM EACH SECTION.

SECTION A - THERMAL ENGINEERING LAB

1. I.C. Engines valve / port timing diagrams.
2. I.C. Engines performance test on 4 -stroke Diesel engine.
3. I.C. Engines performance test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine
5. Determination of FHP by retardation and motoring test on IC engine
6. I.C. Engines heat balance on petrol / Diesel engines.
7. Economical speed test of an IC engine
8. Study of boilers

SECTION B – HYDRAULIC MACHINES LAB

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Reciprocating Pump.
7. Calibration of Venturimeter.
8. Calibration of Orifice meter.
9. Determination of loss of head due to sudden contraction in a pipeline.

II Year – I SEMESTER

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ELECTRICAL CIRCUITS LAB

Learning objectives:

To verify and demonstrate various thermos,locus diagrams, resonance and two port networks.To determine self and mutual inductance of a magnetic circuit, parameters of a given coil and measurement of 3- phase power.

Any 10 of the following experiments are to be conducted:

1) Verification of Thevenin's and Norton's Theorems
2) Verification of Superposition theorem and Maximum Power Transfer Theorem
3) Verification of Compensation Theorem
4) Verification of Reciprocity , Millmann's Theorems
5) Locus Diagrams of RL and RC Series Circuits
6) Series and Parallel Resonance
7) Determination of Self, Mutual Inductances and Coefficient of coupling
8) Z and Y Parameters
9) Transmission and hybrid parameters
10) Parameters of a choke coil.
11) Determination of cold and hot resistance of an electric lamp.
12) Measurement of 3-phase Power by two Wattmeter Method for unbalanced loads

Learning outcomes:

Able to apply various thermos, determination of self and mutual inductances, two port parameters of a given electric circuits. Able to draw locus diagrams. Waveforms and phasor diagram for lagging and leading networks.

II Year – II SEMESTER

L	T	P	C
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ELECTRICAL MEASUREMENTS

Preamble:

This course introduces principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Learning Objectives:

- To study the principle of operation and working of different types of instruments. Measurement of voltage and current.
- To study the working principle of operation of different types of instruments for measurement of power and energy
- To understand the principle of operation and working of dc and ac potentiometers.
- To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
- To study the principle of operation and working of various types of magnetic measuring instruments.
- To study the applications of CRO for measurement of frequency, phase difference and hysteresis loop using Lissajous patterns

UNIT–I:

Measuring Instruments

Classification – Deflecting, control and damping torques – Ammeters and Voltmeters – PMMC, moving iron type, dynamometer and electrostatic instruments – Expression for the deflecting torque and control torque – Errors and compensations– Extension of range using shunts and series resistance –CT and PT**:** Ratio and phase angle errors – Numerical problems..

UNIT –II:

Measurement of Power and Energy

Single phase and three phase dynamometer wattmeter – LPF and UPF – Expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced and unbalanced systems – Type of P.F. Meters – Single phase and three phase dynamometer and moving iron type Single phase induction type energy meter – Driving and braking torques – errors and compensations –Testing by phantom loading using R.S.S. meter– Three phase energy meter – Maximum demand meters– Electrical resonance type frequency meter and Weston type synchro-scope.

UNIT – III:

Potentiometers

Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown resistance – Current – Voltage.AC Potentiometers**:** polar and coordinate types – Standardization – Applications.

UNIT – IV:

Measurements of Parameters

Method of measuring low, medium and high resistance – Sensitivity of Wheat stone's bridge – Carey Foster's bridge– Kelvin's double bridge for measuring low resistance– Loss of charge method for measurement of high resistance – Megger– Measurement of earth resistance – Measurement of inductance – Quality Factor – Maxwell's bridge–Hay's bridge – Anderson's bridge–Measurement of capacitance and loss angle – DesautyBridge – Schering Bridge–Wagner's earthing device–Wien's bridge.

UNIT – V:

Magnetic Measurements

Ballistic galvanometer – Equation of motion – Flux meter – Constructional details– Determination of B–H Loop methods of reversals six point method – AC testing – Iron loss of bar samples– Core loss measurements by bridges and potentiometers.

UNIT – VI:

Digital Meters

Digital Voltmeter–Successive approximation – Measurement of phase difference – Frequency – Hysteresis loop using lissajious patterns in CRO – Ramp and integrating type– Digital frequency meter–Digital multimeter–Digital Tachometer.

Learning Outcomes:

- Able to choose right type of instrument for measurement of voltage and current for ac and dc.
- Able to choose right type of instrument for measurement of power and energy – able to calibrate energy meter by suitable method
- Able to calibrate ammeter and potentiometer.
- Able to select suitable bridge for measurement of electrical parameters
- Able to use the ballistic galvanometer and flux meter for magnetic measuring instruments
- Able to measure frequency and phase difference between signals using CRO. Able to use digital instruments in electrical measurements.

Text Books:

1. Electrical Measurements and measuring Instruments – by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney DhanpatRai & Co.Publications.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand.
3. Electrical Measurements – by Buckingham and Price, Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons
5. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers.
6. Electrical and Electronic Measurements –by G.K.Banerjee, PHI Learning Private Ltd, New Delhi–2012.

II Year – II SEMESTER

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ELECTRICAL MACHINES – II

Preamble:
This course covers the topics on 3-phase induction motor, 1-phase induction motorand synchronous machines which have wide application in power systems. The main aim of the course is to provide a detailedanalysis of operation and performance of 3-phase induction motor, 1-phase induction motorand synchronous machines. In addition,it also covers voltage regulation and parallel operation of synchronous generators.

Learning objectives:

- Understand the principle of operation and performance of 3-phase induction motor.
- Quantify the performance of induction motor and induction generator in terms of torque and slip.
- To understand the torque producing mechanism of a single phase induction motor.
- To understand the principle of emf generation, the effect of armature reaction and predetermination of voltage regulation in synchronous generators.
- To study parallel operation and control of real and reactive powers for synchronous generators.
- To understand the operation, performance and starting methods of synchronous motors.

UNIT-I
3-phase Induction Motors
Construction details of cage and wound rotor machines - production of rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram

UNIT-II
Characteristics, starting and testing methods of Induction Motors
Torque equation - expressions for maximum torque and starting torque - torque slip characteristic - double cage and deep bar rotors - crawling and cogging – speed control of induction motor with V/f method – no load and blocked rotor tests - circle diagram for predetermination of performance– methods of starting – starting current and torque calculations – induction generator operation (Qualitative treatment only)

UNIT – III:
Single Phase Motors
Single phase induction motors – Constructional features and equivalent circuit Problem of starting–Double revolving field theory–Starting methods, shaded pole motors, AC Series motor.

UNIT–IV:
Construction, Operation and Voltage Regulation of Synchronous generator
Constructional features of non–salient and salient pole type – Armature windings – Distributed and concentrated windings – Distribution– Pitch and winding factors –E.M.F equation–Improvements of waveform and armature reaction–Voltage regulation by synchronous impedance method– MMFmethod and Potier triangle method–Phasor diagrams– Two reaction analysis of salient pole machines and phasor diagram.

UNIT –V:

Parallel operation of synchronous generators

Parallel operation with infinite bus and other alternators – Synchronizing power – Load sharing – Control of real and reactive power– Numerical problems.

UNIT–VI:

Synchronous motor – operation, starting and performance

Synchronous Motor principle and theory of operation– Phasor diagram – Starting torque– Variation of current and power factor with excitation –Synchronous condenser – Mathematical analysis for power developed– Hunting and its suppression – Methods of starting – Applications.

Learning outcomes:

- Able to explain the operation and performance of three phase induction motor.
- Able to analyze the torque-speed relation, performance of induction motor and induction generator.
- Able to explain design procedure for transformers and three phase induction motors.
- Implement the starting of single phase induction motors.
- To perform winding design and predetermine the regulation of synchronous generators.
- Avoid hunting phenomenon, implement methods of staring and correction of power factor with synchronous motor.

Text Books:

1. Electrical Machines – P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans, TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,McGrawHill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition
3. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education 2015
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010
5.Electric Machines by MulukutlaS.Sarma&Mukeshk.Pathak, CENGAGE Learning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons

II Year – II SEMESTER

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SWITCHING THEORY AND LOGIC DESIGN

UNIT – I

REVIEW OF NUMBER SYSTEMS & CODES:

i) Representation of numbers of different radix, conversation from one radix to another radix, r-1's compliments and r's compliments of signed members, problem solving.
ii) 4 bit codes, BCD, Excess-3, 2421, 84-2-1 $9^{'s}$ compliment code etc.,
iii) Logic operations and error detection & correction codes; Basic logic operations - NOT, OR, AND, Universal building blocks, EX-OR, EX-NOR - Gates, Standard SOP and POS, Forms, Gray code, error detection, error correction codes (parity checking, even parity, odd parity, Hamming code) NAND-NAND and NOR-NOR realizations.

UNIT – II

MINIMIZATION TECHNIQUES:

Boolean theorems, principle of complementation & duality, De-morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 6 variables, tabular minimization, problem solving (code-converters using K-Map etc..).

UNIT – III

COMBINATIONAL LOGIC CIRCUITS DESIGN :

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders, 4-bit binary subtractor, adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit, look-a-head adder circuit, Design of decoder, demultiplexer, 7 segment decoder, higher order demultiplexing, encoder, multiplexer, higher order multiplexing, realization of Boolean functions using decoders and multiplexers, priority encoder, 4-bit digital comparator.

UNIT – IV

INTRODUCTION OF PLD's :

PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA, programming tables of PROM, PAL, PLA.

UNIT – V

SEQUENTIAL CIRCUITS I:

Classification of sequential circuits (synchronous and asynchronous); basic flip-flops, truth tables and excitation tables (nand RS latch, nor RS latch, RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals). Conversion from one flip-flop to flip-flop. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift register.

UNIT – VI

SEQUENTIAL CIRCUITS II :

Finite state machine; Analysis of clocked sequential circuits, state diagrams, state tables, reduction of state tables and state assignment, design procedures. Realization of circuits using various flip-flops. Meelay to Moore conversion and vice-versa.

TEXT BOOKS:

1. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition.
2. Switching Theory and Logic Design by A. Anand Kumar
3. Digital Design by Mano PHI.

REFERENCE BOOKS:

1. Modern Digital Electronics by RP Jain, TMH
2. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers
3. Micro electronics by Milliman MH edition.

II Year – II SEMESTER

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CONTROL SYSTEMS

Preamble :

This course introduces the elements of linear control systems and their analysis. Classical methods of design using frequency response. The state space approach for design, modeling and analysis of simple PD,PID controllers.

Learning Objectives:

- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers
- To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locus method.
- To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots and Nyquist stability criterion.
- To discuss basic aspects of design and compensation of linear control systems using Bode plots.
- Ability to formulate state models and analyze the systems. To present the concepts of Controllability and Observability.

UNIT – I:

Mathematical Modeling Of Control Systems

Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer Function of DC Servo motor - AC Servo motor- Synchro, transmitter and receiver - Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

UNIT-II:

Time Response Analysis

Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

UNIT – III:

Stability and Rootlocus Technique

The concept of stability – Routh's stability criterion –limitations of Routh's stability –Root locus concept - construction of root loci (Simple problems)

UNIT–IV:

Frequency Response Analysis

Introduction to Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability criterion.

UNIT–V:

Classical Control Design Techniques

Lag, Lead, Lag-Lead compensators, design of compensators – using Bode plots.

UNIT–VI:

State Space Analysis OfLti Systems

Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Learning Outcome:

- Ability to derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- Capability to determine time response specifications of second order systems and to determine error constants.
- Acquires the skill to analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- Capable to analyze the stability of LTI systems using frequency response methods.
- Able to design Lag, Lead, Lag-Lead compensators to improve system performance from Bode diagrams.
- Ability to represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:

1. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India,2nd Edition.

Reference Books:

1.Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India.
2.Control Systems, ManikDhanesh N, Cengage publications.
3.Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
4. Control Systems Engineering, S.Palani,TataMcGraw Hill Publications.

II Year – II SEMESTER

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POWER SYSTEMS-I

Preamble:
Electrical Power plays significant role in day to day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

Learning objectives :

- To study the principle of operation of different components of a thermal power stations.
- To study the principle of operation of different components of a Nuclear power stations.
- To study the concepts of DC/AC distribution systems and voltage drop calculations.
- To study the constructional and operation of different components of an Air and Gas Insulated substations.
- To study theconstructionaldetails of different typesof cables.
- To study different types of load curves and tariffs applicable to consumers.

UNIT-I Thermal Power Stations
Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system, Brief description of components: Boilers, Super heaters, Economizers, electrostatic precipitators steam Turbines : Impulse and reaction turbines, Condensers, feed water circuit, Cooling towers and Chimney.

UNIT-II Nuclear Power Stations
Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components : Moderators, Control rods, Reflectors and Coolants.Types of Nuclear reactors and brief description of PWR, BWR and FBR.Radiation: Radiation hazards and Shielding, nuclear waste disposal.

UNIT-III Distribution Systems
Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT-IV Substations
Classification of substations:
Air Insulated Substations - Indoor & Outdoor substations, Substations layouts of 33/11 kV showing the location of all the substation equipment.
Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.
Gas Insulated Substations (GIS) – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, constructional aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

UNIT-V Underground Cables

Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation and power factor of cable.

Capacitance of single and 3-Core belted Cables: Grading of Cables-Capacitance grading and Inter sheath grading.

UNIT-VI Economic Aspects of Power Generation & Tariff

Economic Aspects - Load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, power capacity factor and plant use factor, Base and peak load plants.

Tariff Methods- Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Desirable Characteristics of a Tariff Method, Tariff Methods: Simple rate, Flat Rate, Block-Rate, two-part, three–part, and power factor tariff methods.

Learning Outcomes:

- Students are able to identify the different components of thermal power plants.
- Students are able to identify the different components of nuclear Power plants.
- Students are able to distinguish between AC/DC distribution systems and also estimate voltage drops of distribution systems.
- Students are able to identifythe different components of air and gas insulated substations.
- Students are able to identifysingle core and multi core cables with different insulating materials.
- Students are able to analyzethe different economic factors of power generation and tariffs.

Text Books:

1. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagarand A. Chakrabarti, DhanpatRai& Co. Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers.

Reference Books:

1. Electrical Power Distribution Systems by - V. Kamaraju, TataMcGraw Hill, New Delhi.
2. Elements of Electrical Power Station Design by – M V Deshpande, PHI, New Delhi.

II Year – II SEMESTER

L	T	P	C
4	0	0	3

MANAGEMENT SCIENCE

Course Objectives:

***To familiarize with the process of management and to provide basic insight into select contemporary management practices**

***To provide conceptual knowledge on functional management and strategic management.**

Unit I

Introduction to Management: Concept –nature and importance of Management –Generic Functions of Management – Evaluation of Management thought- Theories of Motivation – Decision making process-Designing organization structure- Principles of organization – Organizational typology- International Management: Global Leadership and Organizational behavior Effectiveness(GLOBE) structure

Unit II

Operations Management: Principles and Types of Management – Work study- Statistical Quality Control- Control charts (P-chart, R-chart, and C-chart) Simple problems- Material Management: Need for Inventory control- EOQ, ABC analysis (simple problems) and Types of ABC analysis (HML, SDE, VED, and FSN analysis).

Unit III

Functional Management: Concept of HRM, HRD and PMIR- Functions of HR Manager-Wage payment plans(Simple Problems) – Job Evaluation and Merit Rating - Marketing Management- Functions of Marketing – Marketing strategies based on product Life Cycle, Channels of distributions. Operationlizing change through performance management.

Unit IV

Project Management: (PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path- Probability- Project Crashing (Simple Problems)

Unit V

Strategic Management: Vision, Mission, Goals, Strategy – Elements of Corporate Planning Process – Environmental Scanning – SWOT analysis- Steps in Strategy Formulation and Implementation, Generic Strategy Alternatives. Global strategies, theories of Multinational Companies.

Unit VI

Contemporary Management Practice: Basic concepts of MIS, MRP, Justin- Time(JIT) system, Total Quality Management(TQM), Six sigma and Capability Maturity Model(CMM) Levies, Supply Chain Management , Enterprise Resource Planning (ERP), Business Process outsourcing (BPO), Business process Re-engineering and Bench Marking, Balanced Score Card.

Course Outcome:

***After completion of the Course the student will acquire the knowledge on management functions, global leadership and organizational behavior.**

***Will familiarize with the concepts of functional management project management and strategic management.**

References:

Text Books

1. Dr. P. Vijaya Kumar & Dr. N. Appa Rao, '*Management Science'* Cengage, Delhi, 2012.
2. Dr. A. R. Aryasri, *Management Science'* TMH 2011.

References

1. Koontz & Weihrich: 'Essentials *of management'* TMH 2011
2. Seth & Rastogi: Global Management Systems, Cengage learning , Delhi, 2011
3. Robbins: Organizational Behaviour, Pearson publications, 2011
4. Kanishka Bedi: Production & Operations Management, Oxford Publications, 2011
5. Philip Kotler & Armstrong: Principles of Marketing, Pearson publications
6. Biswajit Patnaik: Human Resource Management, PHI, 2011
7. Hitt and Vijaya Kumar: Starategic Management, Cengage learning
8. Prem Chadha: Performance Management, Trinity Press(An imprint of Laxmi Publications Pvt. Ltd.) Delhi 2015.
9. Anil Bhat& Arya Kumar : Principles of Management, Oxford University Press, New Delhi, 2015.

II Year – II SEMESTER

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ELECTRICAL MACHINES – I LABORATORY

Learning objectives:

- To plot the magnetizing characteristics of DC shunt generator and understand the mechanism of self-excitation.
- To control the speed of the DC motors.
- Determine and predetermine the performance of DC machines.
- To predetermine the efficiency and regulation of transformers and assess their performance.

Any 10 of the following experiments are to be conducted

1. Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.
2. Brake test on DC shunt motor. Determination of performance curves.
3. Hopkinson's test on DC shunt machines. Predetermination of efficiency.
4. Swinburne's test and Predetermination of efficiencies as Generator and Motor.
5. Speed control of DC shunt motor by Field and armature Control.
6. Retardation test on DC shunt motor. Determination of losses at rated speed.
7. Separation of losses in DC shunts motor.
8. Oc& SC test on single phase transformer.
9. Sumpner's test on single phase transformer.
10. Scott connection of transformers
11. Parallel operation of Single phase Transformers
12. Separation of core losses of a single phase transformer
13. Heat run test on a bank of 3 Nos. of single phase Delta connected transformers

Learning outcomes:

- To determine and predetermine the performance of DC machines and Transformers.
- To control the speed of DC motor.
- To achieve three phase to two phase transformation.

II Year – II SEMESTER

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ELECTRONIC DEVICES AND CIRCUITS LAB

Note: The students are required to perform the experiment to obtain the V-I characteristics and to determine the relevant parameters from the obtained graphs.

Electronic Workshop Practice:

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Coils, Gang Condensers, Relays, Bread Boards.
2. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
3. Soldering Practice- Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function Generator, Regulated Power Supply and CRO.

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List of Experiments: (Minimum of Ten Experiments has to be performed)

1. P-N Junction Diode Characteristics
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
   Part A: V-I Characteristics
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
   Part A: Half-wave Rectifier
   Part B: Full-wave Rectifier
4. BJT Characteristics(CE Configuration)
   Part A: Input Characteristics
   Part B: Output Characteristics
5. FET Characteristics(CS Configuration)
   Part A: Drain Characteristics
   Part B: Transfer Characteristics
6. SCR Characteristics
7. UJT Characteristics
8. Transistor Biasing
9. CRO Operation and its Measurements
10. BJT-CE Amplifier
11. Emitter Follower-CC Amplifier

12. FET-CS Amplifier

Equipment required:

1. Regulated Power supplies
2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital Function Generators
4. Digital Multimeters
5. Decade Résistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analog or Digital)
8. Voltmeters (Analog or Digital)
9. Active & Passive Electronic Components

III Year – I SEMESTER

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POWER SYSTEMS–II

Preamble:

This course is an extension of power systems–I course. It deals with basic theory of transmission lines modeling and their performance analysis. Transient in power system, improvement of power factor and voltage control are discussed in detail. It is important for the student to understand the mechanical design aspects of transmission lines, cables, insulators. These aspects are also covered in detail in this course.

Learning Objectives:

- To compute inductance/capacitance of transmission lines and to understand the concepts of GMD/GMR.
- To study the short and medium length transmission lines, their models and performance.
- To study the performance and modeling of long transmission lines.
- To study the effect of travelling waves on transmission lines.
- To study the factors affecting the performance of transmission lines and power factor improvement methods.
- To discuss sag and tension computation of transmission lines as well as to study the performance of overhead insulators.

UNIT–I:
Transmission Line Parameters
Conductor materials - Types of conductors – Calculation of resistance for solid conductors – Calculation of inductance for single phase and three phase– Single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors-Numerical Problems–Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and three phase–Single and double circuit lines- Bundled conductors–Numerical Problems.

UNIT–II:
Performance of Short and Medium Length Transmission Lines
Classification of Transmission Lines – Short, medium, long line and their model representations –Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks– Numerical Problems– Mathematical Solutions to estimate regulation and efficiency of all types of lines – Numerical Problems.

UNIT–III:
Performance of Long Transmission Lines
Long Transmission Line–Rigorous Solution – Evaluation of A,B,C,D Constants– Interpretation of the Long Line Equations, regulation and efficiency– Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wave Length and Velocity of Propagation of Waves – Representation of Long Lines – Equivalent-T and Equivalent Pie network models (Numerical Problems).

UNIT – IV:

Power System Transients

Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients – Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions.

UNIT–V:

Various Factors governing the Performance of Transmission line

Skin and Proximity effects – Description and effect on Resistance of Solid Conductors – Ferranti effect – Charging Current –Shunt Compensation –Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss – Radio Interference.

UNIT–VI:

Sag and Tension Calculations and Overhead Line Insulators

Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor–Numerical Problems – Stringing chart and sag template and its applications–Types of Insulators – String efficiency and Methods for improvement– Numerical Problems – Voltage distribution–Calculation of string efficiency–Capacitance grading and Static Shielding.

Learning Outcomes:

- Able to understand parameters of various types of transmission lines during different operating conditions.
- Able to understand the performance of short and medium transmission lines.
- Student will be able to understand travelling waves on transmission lines.
- Will be able to understand various factors related to charged transmission lines.
- Will be able to understand sag/tension of transmission lines and performance of line insulators.

Text Books:

1. Electrical power systems – by C.L.Wadhwa, New Age International (P) Limited, Publishers, 1998.
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition

Reference Books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.BhatnagarA.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.
4. Electrical Power Systems by P.S.R. Murthy, B.S.Publications.

III Year – I SEMESTER

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RENEWABLE ENERGY SOURCES

Preamble:

This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, biomass, fuel cells and geothermal systems.

Learning Objectives:

- To study the solar radiation data, extraterrestrial radiation, radiation on earth's surface.
- To study solar thermal collections.
- To study solar photo voltaic systems.
- To study maximum power point techniques in solar pv and wind energy.
- To study wind energy conversion systems, Betz coefficient, tip speed ratio.
- To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

UNIT–I:
Fundamentals of Energy Systems and Solar energy
Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation**:** Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry – Radiation on tilted surfaces – Numerical problems.

UNIT–II:
Solar Thermal Systems
Liquid flat plate collectors**:** Performance analysis –Transmissivity– Absorptivity product collector efficiency factor – Collector heat removal factor – Numerical problems. Introduction to solar air heaters – Concentrating collectors, solar pond and solar still – solar thermal plants.

UNIT–III:
Solar Photovoltaic Systems
Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems – Balance of system components - System design**:** storage sizing – PV system sizing – Maximum power point techniques**:** Perturb and observe (P&O) technique – Hill climbing technique.

UNIT–IV:
Wind Energy
Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency – Power output of wind turbine – Selection of generator(synchronous, induction) – Maximum power point tracking – wind farms – Power generation for utility grids.

UNIT–V:

Hydro and Tidal power systems

Basic working principle – Classification of hydro systems**:** Large, small, micro – measurement of head and flow – Energy equation – Types of turbines – Numerical problems.
Tidal power – Basics – Kinetic energy equation – Turbines for tidal power - Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

UNIT–VI:

Biomass, fuel cells and geothermal systems

Biomass Energy**:** Fuel classification – Pyrolysis – Direct combustion of heat – Different digesters and sizing.
Fuel cell**:** Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics.
Geothermal**:** Classification – Dry rock and hot acquifer – Energy analysis – Geothermal based electric power generation

Learning Outcomes:

Student should be able to

- Analyze solar radiation data, extraterrestrial radiation, and radiation on earth's surface.
- Design solar thermal collectors, solar thermal plants.
- Design solar photo voltaic systems.
- Develop maximum power point techniques in solar PV and wind energy systems.
- Explain wind energy conversion systems, wind generators, power generation.
- Explain basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

Text Books:

1. Solar Energy**:** Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
2. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis - second edition,2013.

Reference Books:

1. Energy Science**:** Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press.
2. Renewable Energy- Edited by Godfrey Boyle-oxford university.press,3rd edition,2013.
3. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
4. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
5. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
6. Non conventional energy source –B.H.khan- TMH-2nd edition.

III Year – I SEMESTER

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SIGNALS & SYSTEMS

OBJECTIVES:

The main objectives of this course are given below:

- To introduce the terminology of signals and systems.
- To introduce Fourier tools through the analogy between vectors and signals.
- To introduce the concept of sampling and reconstruction of signals.
- To analyze the linear systems in time and frequency domains.
- To study z-transform as mathematical tool to analyze discrete-time signals and systems.

UNIT- I: INTRODUCTION: Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions.

UNIT –II: FOURIER SERIES AND FOURIER TRANSFORM:
Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform.

UNIT –III: SAMPLING THEOREM – Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling.

UNIT-IV: ANALYSIS OF LINEAR SYSTEMS: Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system, Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Transfer function of a LTI system. Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Poly-Wiener criterion for physical realization, relationship between bandwidth and rise time.

Cross-correlation and auto-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

UNIT –V: LAPLACE TRANSFORMS : Review of Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Relation

between L.T's, and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.

UNIT –VI: Z–TRANSFORMS : Fundamental difference between continuous-time and discrete-time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal, Concept of Z- Transform of a discrete sequence. Distinction between Laplace, Fourier and Z transforms. Region of convergence in
Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms.

TEXT BOOKS:

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
3. Signals & Systems- Narayan Iyer and K Satya Prasad, Cenage Pub.

REFERENCE BOOKS:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition.
2. Principles of Linear Systems and Signals – BP Lathi, Oxford University Press, 2015
3. Signals and Systems – K Raja Rajeswari, B VisweswaraRao, PHI, 2009
4. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008.
5. Signals and Systems – T K Rawat , Oxford University press, 2011

OUTCOMES:

At the end of this course the student will able to:

- Characterize the signals and systems and principles of vector spaces, Concept of orthgonality.
- Analyze the continuous-time signals and continuous-time systems using Fourier series, Fourier transform and Laplace transform.
- Apply sampling theorem to convert continuous-time signals to discrete-time signal and reconstruct back.
- Understand the relationships among the various representations of LTI systems
- Understand the Concepts of convolution, correlation, Energy and Power density spectrum and their relationships.
- Apply z-transform to analyze discrete-time signals and systems.

III Year – I SEMESTER

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PULSE AND DIGITAL CIRCUITS OBJECTIVES

The student will be made

- To understand the concept of wave shaping circuits, Switching Characteristics of diode and transistor.
- To study the design and analysis of various Multivibrators.
- To understand the functioning of different types of time-base Generators.
- To learn the working of logic families & Sampling Gates.

UNIT I

LINEAR WAVESHAPING: High pass, low pass RC circuits, their response for sinusoidal, step, pulse, square, ramp and exponential inputs. RC network as differentiator and integrator; Attenuators , its applications in CRO probe, RL and RLC circuits and their response for step input, Ringing circuit.

UNIT II

NON-LINEAR WAVE SHAPING : Diode clippers, Transistor clippers, clipping at two independent levels, Transfer characteristics of clippers, Emitter coupled clipper; Clamping operation, clamping circuits using diode with different inputs, Clamping circuit theorem, practical clamping circuits, effect of diode characteristics on clamping voltage, Transfer characteristics of clampers.

UNIT III

SWITCHING CHARACTERISTICS OF DEVICES : Diode as a switch, piecewise linear diode characteristics, Design and analysis of Transistor as a switch, Break down voltage consideration of transistor, saturation parameters of Transistor and their variation with temperature, Design of transistor switch, transistor-switching times.

Bistable Multivibrator: Analysis And Design of Fixed Bias, Self Bias Bistable Multi Vibrator, Collector Catching Diodes, Commutating Capacitors, Triggering of Binary Circuits, Emitter Coupled Bistable Multivibrator (Schmitt Trigger).

UNIT IV

Monostable Multivibrator: Analysis and Design of Collector Coupled Monostable Multi vibrator, Triggering of Monostable Multivibrator, Applications of Monostable Multivibrator.

Astable Multivibrator: Analysis and Design of Collector Coupled Astable Multivibrator, Application of Astable Multivibrator as a Voltage to Frequency Converter.

UNIT V

VOLTAGE TIME BASE GENERATORS:

General features of a time base signal, Methods of generating time base waveform Exponential Sweep Circuits, Negative Resistance Switches, basic principles in Miller and Bootstrap time base generators, Transistor Miller time base generator, Transistor Bootstrap time base generator.

UNIT VI

LOGIC FAMILIES & SAMPLING GATES:

LOGIC FAMILIES: Diode Logic, Transistor Logic, Diode-Transistor Logic, Transistor-Transistor Logic, Emitter Coupled Logic, AOI Logic, Comparison of Logic Families.

SAMPLING GATES: Basic Operating Principles of Sampling Gates, Diode Unidirectional Sampling Gate and Two-Diode Bi-Directional Sampling Gate, Four-Diode gates, Six-Diode Gates, Reduction of Pedestal in Sampling Gates, Applications of Sampling Gates.

TEXT BOOKS:

1. Pulse, Digital and Switching Waveforms - J. Millman and H. Taub, McGraw-Hill
2. Pulse and Digital Circuits – A. Anand Kumar, PHI, 2005

REFERENCES :

1.Pulse, Digital and Switching Waveforms - J. Millman and H. Taub, Mothiki S Prakash Rao McGraw-Hill, Second Edition, 2007.
2. Solid State Pulse circuits - David A. Bell, PHI, 4th Edn., 2002
3. Pulse & Digital Circuits by Venkata Rao,K,Ramasudha K, Manmadha Rao,G., Pearson,2010

OUTCOMES

After going through this course the student will be able to

- Design linear and non-linear wave shaping circuits.
- Apply the fundamental concepts of wave shaping for various switching and signal generating circuits.
- Design different multivibrators and time base generators.
- Utilize the non sinusoidal signals in many experimental research areas.

III Year – I SEMESTER

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POWER ELECTRONICS

Preamble:

The usage of power electronics in day to day life has increased in recent years. It is important for student to understand the fundamental principles behind all these converters. This course covers characteristics of semiconductor devices, ac/dc, dc/dc, ac/ac and dc/ac converters. The importance of using pulse width modulated techniques to obtain high quality power supply (dc/ac converter) is also discussed in detail in this course.

Learning Objectives:

- To study the characteristics of various power semiconductor devices and to design firing circuits for SCR.
- To understand the operation of single phase full–wave converters and analyze harmonics in the input current.
- To study the operation of three phase full–wave converters.
- To understand the operation of different types of DC-DC converters.
- To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.
- To analyze the operation of AC-AC regulators.

UNIT–I:
Power Semi-Conductor Devices
Thyristors–Silicon controlled rectifiers (SCR's) –Characteristics of power MOSFET and power IGBT– Basic theory of operation of SCR–Static characteristics– Turn on and turn off methods–Dynamic characteristics of SCR– Snubber circuit design– Basic requirements of gating circuits for SCR, IGBT and MOSFET.

UNIT–II:
AC-DCSingle-Phase Converters
1-phase half wave controlled rectifiers – R load and RL load with and without freewheeling diode – 1-phase full wave controlled rectifiers – center tapped configuration and bridge configuration- R load and RL load with and without freewheeling diode – continuous and discontinuous conduction – Effect of source inductance in 1-phase fully controlled bridge rectifier with continuous conduction.

UNIT–III:
AC-DC3-Phase Converters
3-phase half wave and Full wave uncontrolled rectifier – 3-phase half wave controlled rectifier with R and RL load – 3-phase fully controlled rectifier with R and RL load – 3-phase semi controlled rectifier with R and RL load.

UNIT–IV:
DC–DC Converters
Analysis of Buck, boost and buck, buck-boost converters in ContinuousConduction Mode (CCM) and Discontinuous Conduction Modes (DCM) – Output voltage equations using volt-sec balance in CCM & DCM output voltage ripple & inductor current, ripple for CCM only – Principle operation of forward and fly back converters in CCM.

UNIT – V:

DC–AC Converters

1- phase halfbridge and full bridge inverters with R and RL loads – 3-phase square wave inverters – 120^0 conduction and 180^0 conduction modes of operation – PWM inverters – Quasi-square wave pulse width modulation – Sinusoidal pulse width modulation – Prevention of shoot through fault in Voltage Source Inverter (VSI) – Current Source Inverter (CSI) – Introduction to Auto Sequential Commutated Current Source Inverter (ASCCSI) .

UNIT – VI:

AC – AC Regulators.

Static V-I characteristics of TRIAC and modes of operation – 1-phase AC-AC regulator phase angle control and integrated cycle control with R and RL load – For continuous and discontinuous conduction- 3-Phase AC-AC regulators with R load only – Transformer tap changing using antiparallel Thyristors.

Learning Outcomes:

Student should be able to

- Explain the characteristics of various power semiconductor devices and analyze the static and dynamic characteristics of SCR's.
- Design firing circuits for SCR.
- Explain the operation of single phase full–wave converters and analyze harmonics in the input current.
- Explain the operation of three phase full–wave converters.
- Analyze the operation of different types of DC-DC converters.
- Explain the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.
- Analyze the operation of AC-AC regulators.

Text Books:

1. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998
2. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009

Reference Books:

1. Elements of Power Electronics–Philip T.Krein.oxford.
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.
5. Power Electronics: converters, applications & design -by Nedmohan, Tore M. Undeland, Robbins by Wiley India Pvt. Ltd.
6. Power Converter Circuits -by William Shepherd, Li zhang, CRC Taylor & Francis Group.

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III Year – I SEMESTER	**0**	**0**	**3**	**2**

ELECTRICAL MACHINES – II LABORATORY

Learning objectives:

- To control the speed of three phase induction motors.
- To determine /predetermine the performance three phase and single phase induction motors.
- To improve the power factor of single phase induction motor .
- To predetermine the regulation of three–phase alternator by various methods, find X_d/ $X_q$ratio of alternator and asses the performance of three–phase synchronous motor.

The following experiments are required to be conducted as compulsory experiments:

1. Brake test on three phase Induction Motor
2. No–load & Blocked rotor tests on three phase Induction motor
3. Regulation of a three –phase alternator by synchronous impedance &m.m.f. Methods
4. Regulation of three–phase alternator by Potier triangle method
5. V and Inverted V curves of a three—phase synchronous motor.
6. Determination of X_d and X_q of a salient pole synchronous machine
7. Equivalent circuit of single phase induction motor
8. Speed control of induction motor by V/f method.
9. Determination of efficiency of three phase alternator by loading with three phase induction motor.
10. Power factor improvement of single phase induction motor by using capacitors and load test on single phase induction motor.

Learning outcomes:

- Able to assess the performance ofsingle phase and three phase induction motors.
- Able to control the speed of three phase induction motor.
- Able to predetermine the regulation of three–phase alternator by various methods.
- Able to find the X_d/ $X_q$ratio of alternator and asses the performance of three–phase synchronous motor.

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III Year – I SEMESTER

L	T	P	C
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CONTROL SYSTEMS LAB

Learning Objectives:

- To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors, stepper motor and potentiometer.
- To understand time and frequency responses of control system with and without controllers and compensators.

Any 10 of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Programmable logic controller – characteristics of stepper motor
4. Effect of feedback on DC servo motor
5. Effect of P, PD, PI, PID Controller on a second order systems
6. Lag and lead compensation – Magnitude and phase plot
7. DC position control system
8. Transfer function of DC motor
9. Temperature controller using PID
10. Characteristics of magnetic amplifiers
11. Characteristics of AC servo motor
12. Characteristics of DC servo motor
13. Potentiometer as an error detector

Learning Outcomes

- Able to analyze the performance and working Magnetic amplifier, D.C and A.C. servo motors and synchronous motors.
- Able to design P,PI,PD and PID controllers
- Able to design lag, lead and lag–lead compensators
- Able to control the temperature using PID controller
- Able to determine the transfer function of D.C.motor
- Able to control the position of D.C servo motor performance

III Year – I SEMESTER

L	T	P	C
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ELECTRICAL MEASUREMENTS LABORATORY

Learning Objectives:

- To understand the correct function of electrical parameters and calibration of voltage, current, single phase and three phase power and energy, and measurement of electrical characteristics of resistance, inductance and capacitance of a circuits through appropriate methods.
- To understand testing of transformer oil.

Any 10 of the following experiments are to be conducted

1. Calibration and Testing of single phase energy Meter
2. Calibration of dynamometer wattmeter using phantom loading
3. Calibration of PMMC ammeter and voltmeter using Crompton D.C. Potentiometer
4. Measurement of resistance and Determination of Tolerance using Kelvin's double Bridge.
5. Capacitance Measurement using Schering bridge.
6. Inductance Measurement using Anderson bridge.
7. Measurement of 3 phase reactive power with single phase wattmeter for balanced loading.
8. Calibration of LPF wattmeter by direct loading.
9. Measurement of 3 phase power with single watt meter and using two C.Ts.
10. Testing of C.T. using mutual inductance method.
11. Testing of P.T. using absolute null method.
12. Dielectric oil testing using H.T test Kit.
13. Calibration of AC voltmeter and measurement of choke parameters using AC Potentiometer in polarform.
14. Measurement of Power by 3 Voltmeter and 3 Ammeter method.

Learning Outcomes:

- To be able to measure the electrical parameters voltage, current, power, energy and electrical characteristics of resistance, inductance and capacitance.
- To be able to test transformer oil for its effectiveness.
- To be able to measure the parameters of inductive coil.

III Year – I SEMESTER

L	T	P	C
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INTELLECTUAL PROPERTY RIGHTS AND PATENTS

Objectives:

***To know the importance of Intellectual property rights, which plays a vital role in advanced Technical and Scientific disciplines.**

***Imparting IPR protections and regulations for further advancement, so that the students can familiarize with the latest developments.**

Unit I: Introduction to Intellectual Property Rights (IPR)

Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.

Unit II: Copyrights and Neighboring Rights

Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers **–** Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Case Law - Semiconductor Chip Protection Act.

Unit III: Patents

Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent - Exclusive Rights – Limitations - Ownership and Transfer — Revocation of Patent – Patent Appellate Board - Infringement of Patent – Compulsory Licensing — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations.

Unit IV: Trademarks

Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Deceptive Similarities - Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies – Passing Off Action.

Unit V: Trade Secrets

Introduction to Trade Secrets – General Principles - Laws Relating to Trade Secrets - Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreements – Breach of Contract –Law of Unfair Competition – Trade Secret Litigation – Applying State Law.

Unit VI: Cyber Law and Cyber Crime

Introduction to Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions - E-commerce - Data Security – Authentication and Confidentiality - Privacy - Digital Signatures – Certifying Authorities - Cyber Crimes - Prevention and Punishment – Liability of Network Providers.

- Relevant Cases Shall be dealt where ever necessary.

Outcome:

*** IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents.**

***Student get an insight on Copyrights, Patents and Software patents which are instrumental for further advancements.**

References:

1. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi.
2. Deborah E.Bouchoux: Intellectual Property, Cengage Learning, New Delhi.
3. PrabhuddhaGanguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
4. Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
5. Kompal Bansal &Parishit Bansal Fundamentals of IPR for Engineers, B. S. Publications (Press).
6. Cyber Law - Texts & Cases, South-Western's Special Topics Collections.
7. R.Radha Krishnan, S.Balasubramanian: Intellectual Property Rights, Excel Books. New Delhi.
8. M.Ashok Kumar and MohdIqbal Ali: Intellectual Property Rights, Serials Pub.

III Year – II SEMESTER

L	T	P	C
4	0	0	3

POWER ELECTRONIC CONTROLLERS & DRIVES

Preamble:

This course is an extension of power electronics applications to electric drives. This course covers in detail the basic and advanced speed control techniques using power electronic converters that are used in industry. It is equally important to understand the four quadrant operation of electric drives and slip power recovery schemes in induction motors.

Learning Objectives:

- To learn the fundamentals of electric drive and different electric braking methods.
- To analyze the operation of three phase converter controlled dc motors and four quadrant operation of dc motors using dual converters.
- To discuss the converter control of dc motors in various quadrants.
- To understand the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
- To learn the principles of static rotor resistance control and various slip power recovery schemes.
- To understand the speed control mechanism of synchronous motors

UNIT–I:
Fundamentals of Electric Drives
Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

UNIT–II:
Controlled Converter Fed DC Motor Drives
1-phase half and fully controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics — Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.

UNIT–III:
DC–DC Converters Fed DC Motor Drives
Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excitedDC motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics –Four quadrant operation – Closed loop operation (qualitative treatment only).

UNIT–IV:
Stator side control of 3-phase Induction motor Drive
Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor byPWMvoltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only).

UNIT–V:

Rotor side control of 3-phase Induction motor Drive

Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.

UNIT–VI:

Control of Synchronous Motor Drives

Separate control & self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI– Closed Loop control operation of synchronous motor drives (qualitative treatment only).–Variable frequency control–Pulse width modulation.

Learning Outcomes:

After completion of the course, studentswill be able to:

- Explain the fundamentals of electric drive and different electric braking methods.
- Analyze the operation of three phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
- Describe the converter control of dc motors in various quadrants of operation
- Know the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
- Differentiate the stator side control and rotor side control of three phase induction motor..
- Explain the speed control mechanism of synchronous motors

Text Books:

1. Fundamentals of Electric Drives – by G K DubeyNarosa Publications
2. Power Semiconductor Drives, by S.B.Dewan, G.R.Slemon, A.Straughen, Wiley-India Edition.

Reference Books:

1.Electric Motors and Drives Fundamentals, Types and Apllications, by Austin Hughes and Bill Drury, Newnes.

2.Thyristor Control of Electric drives – VedamSubramanyam Tata McGraw Hill Publications.

3. Power Electronic Circuits, Devices and applications by M.H.Rashid, PHI

4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.

III Year – II SEMESTER

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4	0	0	3

POWER SYSTEM ANALYSIS

Preamble:

The course is designed to give students the required knowledge for the design and analysis of electrical power grids. Calculation of power flow in a power system network using various techniques, formation of Z_{bus} and its importance are covered in this course. It also deals with short circuit analysis and analysis of power system for steady state and transient stability.

Learning Objectives:

- To development the impedance diagram (p.u) and formation of Y_{bus}
- To study the different load flow methods.
- To study the concept of the Z_{bus}building algorithm.
- To study short circuit calculation for symmetrical faults
- To study the effect of unsymmetrical faults and their effects.
- To study the rotor angle stability of power systems.

UNIT –I:
Per Unit Representation & Topology
Per Unit Quantities–Single line diagram– Impedance diagram of a power system–Graph theory definition – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y–bus matrix by singular transformation and direct inspection methods.

UNIT –II:
Power Flow Studies
Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) –Decoupled and Fast Decoupled methods – Algorithmic approach – Problems on 3–bus system only.

UNIT –III:
Z–Bus formulation
Formation of Z–Bus**:** Partial network– Algorithm for the Modification of Z_{bus} Matrix for addition element for the following cases**:** Addition of element from a new bus to reference– Addition of element from a new bus to an old bus– Addition of element between an old bus to reference and Addition of element between two old busses (Derivations and Numerical Problems).– Modification of Z–Bus for the changes in network (Problems).

UNIT – IV:
Symmetrical Fault Analysis
Transients on a Transmission line-Short circuit of synchronous machine(on no-load) - 3–Phase short circuit currents and reactances of synchronous machine–Short circuit MVA calculations -Series reactors – selection of reactors.

UNIT –V:

Symmetrical Components & Fault analysis

Definition of symmetrical components - symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence impedances – Synchronous generator – Transmission line and transformers – Sequence networks –Various types of faults LG– LL– LLG and LLL on unloaded alternator–unsymmetrical faults on power system.

UNIT – VI:

Power System Stability Analysis

Elementary concepts of Steady state– Dynamic and Transient Stabilities– Description of Steady State Stability Power Limit–Transfer Reactance–Synchronizing Power Coefficient – Power Angle Curve and Determination of Steady State Stability –Derivation of Swing Equation–Determination of Transient Stability by Equal Area Criterion–Applications of Equal Area Criterion–Methods to improve steady state and transient stability.

`Learning Outcomes:

- Able to draw impedance diagram for a power system network and to understand per unit quantities.
- Able to form a$Y_{bus}$and $Z_{bus}$for a power system networks.
- Able to understand the load flow solution of a power system using different methods.
- Able to find the fault currents for all types faults to provide data for the design of protective devices.
- Able to findthe sequence components of currents for unbalanced power system network.
- Able to analyze the steady state, transient and dynamic stability concepts of a power system.

Text Books:

1. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
2. Modern Power system Analysis – by I.J.Nagrath&D.P.Kothari: Tata McGraw–Hill Publishing Company, 2nd edition.

Reference Books:

1. Power System Analysis – by A.R.Bergen, Prentice Hall, Inc.
2. Power System Analysis by HadiSaadat – TMH Edition.
3. Power System Analysis by B.R.Gupta, Wheeler Publications.
4. Power System Analysis and Design by J.Duncan Glover, M.S.Sarma, T.J.Overbye – CengageLearning publications.

III Year – II SEMESTER

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MICROPROCESSORS AND MICROCONTROLLERS

Preamble:

Microprocessor and microcontroller have become important building blocks in digital electronics design. It is important for student to understand the architecture of a microprocessor and its interfacing with various modules. 8086 microprocessor architecture, programming, and interfacing is dealt in detail in this course. Interfacing, PIC, architecture, programming in C.

Learning objectives:

- To understand the organization and architecture of Micro Processor
- To understand addressing modes to access memory
- To understand 8051 micro controller architecture
- To understand the programming principles for 8086 and 8051
- To understand the interfacing of MP with IO as well as other devices
- To understand how to develop cyber physical systems

UNIT–I:
Introduction to Microprocessor Architecture
Introduction and evolution of Microprocessors– Architecture of 8086–Register Organization of 8086–Memory organization of 8086– General bus operation of 8086–Introduction to 80286–80386 and 80486 and Pentium.

UNIT–II:
Minimum and Maximum Mode Operations
Instruction set, Addressing modes– Minimum and Maximum mode operations of 8086–8086 Control signal interfacing–Read and write cycle timing diagrams.

UNIT–III:
I/O Interface
8255 PPI– Architecture of 8255–Modes of operation– Interfacing I/O devices to 8086 using 8255–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing– Static memory interfacing with 8086–DMA controller (8257)–Architecture–Interfacing 8257 DMA controller– Programmable Interrupt Controller (8259)–Command words and operating modes of 8259– Interfacing of 8259–Keyboard/display controller (8279)–Architecture–Modes of operation–Command words of 8279– Interfacing of 8279.

UNIT–IV:
Introduction to 8051 Micro Controller
Overview of 8051 Micro Controller– Architecture– Register set–I/O ports and Memory Organization– Interrupts–Timers and Counters–Serial Communication.

UNIT– V:
PIC Architecture
Block diagram of basic PIC 18 micro controller, registers I/O ports.

UNIT– VI:
Programming in C for PIC
Data types, I/O programming, logical operations, data conversion

Learning Outcomes:

- To be able to understand the microprocessor capability in general and explore the evaluation of microprocessors.
- To be able to understand the addressing modes of microprocessors
- To be able to understand the micro controller capability
- To be able to program mp and mc
- To be able to interface mp and mc with other electronic devices
- To be able to develop cyber physical systems

Text Books:

1. Kenneth J Ayala, "The 8051 Micro Controller Architecture, Programming and Applications", Thomson Publishers, 2nd Edition.
2. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18, - Muhammad Ali Mazidi, RolindD.Mckinay , Danny causey -Pearson Publisher 21st Impression.

Reference Books:

1. R.S. Kaler, " A Text book of Microprocessors and Micro Controllers", I.K. International Publishing House Pvt. Ltd.
2. Ajay V. Deshmukh, "Microcontrollers – Theory and Applications", Tata McGraw–Hill Companies –2005.
3. Ajit Pal, "Microcontrollers – Principles and Applications", PHI Learning Pvt Ltd, 2011.
4. Microprocessors and Interfacing, Douglas V Hall, Mc–Graw Hill, 2nd Edition.
5. Ray and Burchandi, "Advanced Micro Processors and Interfacing", Tata McGraw–Hill.

III Year – II SEMESTER

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DATA STRUCTURES THROUGH C++

OBJECTIVES:

- To be familiar with basic techniques of object oriented principles and exception handling using C++
- To be familiar with the concepts like Inheritance, Polymorphism
- Solve problems using data structures such as linear lists, stacks, queues, hash tables
- Be familiar with advanced data structures such as balanced search trees, AVLTrees, and B Trees.

UNIT-I: ARRAYS

Abstract Data Types and the C++ Class, An Introduction to C++ Class- Data Abstraction and Encapsulation in C++- Declaring Class Objects and Invoking Member Functions- Special Class Operations- Miscellaneous Topics- ADTs and C++Classes, The Array as an Abstract Data Type, The Polynomial Abstract Data type- Polynomial Representation- Polynomial Addition. Spares Matrices,Introduction- Sparse Matrix Representation- Transposing a Matrix- Matrix Multiplication, Representation of Arrays.

UNIT-II: STACKS AND QUEUES

Templates in C++, Template Functions- Using Templates to Represent Container Classes, The Stack Abstract Data Type, The Queue Abstract Data Type, Subtyping and Inheritance in C++, Evaluation of Expressions, Expression- Postfix Notation- Infix to Postfix.

UNIT-III: LINKED LISTS

Single Linked List and Chains, Representing Chains in C++, Defining a Node in C++- Designing a Chain Class in C++- Pointer manipulation in C++- Chain Manipulation Operations, The Template Class Chain, Implementing Chains with Templates- Chain Iterators- Chain Operations- Reusing a Class, Circular Lists, Available Space Lists, Linked Stacks and Queues, Polynomials, Polynomial Representation- Adding Polynomials- Circular List Representation of Polynomials, Equivalence Classes, Sparse Matrices, Sparse Matrix Representation- Sparse Matrix Input- Deleting a Sparse Matrix, Doubly Linked Lists, Generalized Lists, Representation of Generalized Lists- Recursive Algorithms for Lists- Reference Counts, Shared and Recursive Lists

UNIT-IV: TREES

Introduction, Terminology, Representation of Trees, Binary Trees, The Abstract Data Type, Properties of Binary Tress, Binary Tree Representations, Binary Tree Traversal and Tree Iterators, Introduction, Inorder Traversal Preorder Traversal, Postorder Traversal, Thread Binary Trees, Threads, Inorder Traversal of a Threaded Binary Tree, Inserting a Node into a Threaded Binary Tree, Heaps, Priority Queues, Definition of a Max Heap, Insertion into a Max Heap, Deletion from a Max Heap, Binary Search Trees, Definition, Searching a Binary Search Tree, Insertion into a Binary Search Tree, Deletion from a Binary Search Tree, Height of Binary Search Tree.

UNIT-V: GRAPHS

The Graph Abstract Data Type, Introduction, Definition, Graph Representation, Elementary Graph Operation, Depth First Search, Breadth First Search, Connected Components, Spanning Trees, Biconnected Components, Minimum Cost Spanning Trees, Kruskal S Algorithm, Prim s Algorithm Sollin' s Algorithm, Shortest Paths and Transitive Closure, Single Source/All Destination: Nonnegative Edge Cost, Single Source/All Destination: General Weights, All-Pairs Shortest Path, Transitive Closure.

UNIT-VI: SORTING

Insertion Sort, Quick Sort, Merge Sort Merging, Iterative Merge Sort, Recursive Merge Sort, Heap Sort.

OUTCOMES:

- Distinguish between procedures and object oriented programming.
- Apply advanced data structure strategies for exploring complex data structures.
- Compare and contrast various data structures and design techniques in the area of Performance.
- Implement data structure algorithms through C++. • Incorporate data structures into the applications such as binary search trees, AVL and B Trees
- Implement all data structures like stacks, queues, trees, lists and graphs and compare their Performance and trade offs

TEXT BOOKS:

1. Data structures, Algorithms and Applications in C++, S.Sahni, University Press (India) Pvt.Ltd, 2nd edition, Universities Press, Pvt. Ltd.
2. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education. Ltd.Second, Edition.
3. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and .Mount, Wiley student edition, John Wiley and Sons.

REFERENCE BOOKS:

1.Data structures and algorithms in C++, 3rd Edition, Adam Drozdek, Thomson
2.Data structures using C and C++, Langsam, Augenstein and Tanenbaum, PHI.
3. Problem solving with C++, The OOP, Fourth edition, W.Savitch, Pearson education.

III Year – II SEMESTER

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UNIX AND SHELL PROGRAMMIN
OPEN ELECTIVE

OBJECTIVES:

- Written technical communication and effective use of concepts and terminology.
- Facility with UNIX command syntax and semantics.
- Ability to read and understand specifications, scripts and programs.
- Individual capability in problem solving using the tools presented within the class. Students will demonstrate a mastery of the course materials and concepts within in class
  discussions.

UNIT-I

Introduction to unix-Brief History-What is Unix-Unix Components-Using Unix-Commands in Unix-Some Basic Commands-Command Substitution-Giving Multiple Commands.

UNIT-II

The File system –The Basics of Files-What's in a File-Directories and File Names-Permissions-I Nodes-The Directory Hierarchy, File Attributes and Permissions-The File Command knowing the File Type-The Chmod Command Changing File Permissions-The Chown Command Changing the Owner of a File-The Chgrp Command Changing the Group of a File.

UNIT-III

Using the Shell-Command Line Structure-Met characters-Creating New Commands-Command Arguments and Parameters-Program Output as Arguments-Shell Variables- -More on I/O Redirection-Looping in Shell Programs.

UNIT-IV

Filters-The Grep Family-Other Filters-The Stream Editor Sed-The AWK Pattern Scanning and processing Language-Good Files and Good Filters.

UNIT-V

Shell Programming-Shell Variables-The Export Command-The Profile File a Script Run During Starting-The First Shell Script-The read Command-Positional parameters-The $? Variable knowing the exit Status-More about the Set Command-The Exit Command-Branching Control Structures-Loop Control Structures-The Continue and Break Statement-The Expr Command: Performing Integer Arithmetic-Real Arithmetic in Shell Programs-The here Document(<<)-The Sleep Command-Debugging Scripts-The Script Command-The Eval Command-The Exec Command.

UNIT-VI

The Process-The Meaning-Parent and Child Processes-Types of Processes-More about Foreground and Background processes-Internal and External Commands-Process Creation-The Trap Command-The Stty Command-The Kill Command-Job Control.

OUTCOMES:

- Documentation will demonstrate good organization and readability.
- File processing projects will require data organization, problem solving and research.
- Scripts and programs will demonstrate simple effective user interfaces.
- Scripts and programs will demonstrate effective use of structured programming.
- Scripts and programs will be accompanied by printed output demonstrating completion of a test plan.
- Testing will demonstrate both black and glass box testing strategies.
- Project work will involve group participation.

TEXT BOOKS:

1. Introduction to Unix Shell Programming by M.G.Venkateshmurthy, Parson.
2. Unix programming environment by Brain W. Kernighan & Rob Pike, Pearson.

REFERENCE BOOKS:

1. Unix and shell programmingby B.M. Harwani, OXFORD university press.

OOPs through Java

OBJECTIVE:

- To strengthen their problem solving ability by applying the characteristics of an object- oriented approach.
- To introduce object oriented concepts in C++ and Java.

Programming:

1. Write a Programme that computes the simple interest and compound interest payable on principal amount (in Rs.) of loan borrowed by the customer from a bank for a giver period of time (in years) at specific rate of interest. Further determine whether the b bank will benefit by charging simple interest or compound interest

2. Write a Programme to calculate the fare for the passengers traveling in a bus. When a Passenger enters the bus, the conductor asks "What distance will you travel?" On knowing distance from passenger (as an approximate integer), the conductor mentions the fare to the passenger according to following criteria.
3. Write a C++ Program to illustrate Enumeration and Function Overloading

4. Write a C++ Program to illustrate Scope and Storage class

5. Implementation of ADT such as Stack and Queues

6. Write a C++ Program to illustrate the use of Constructors and Destructors and Constructor Overloading

7. Write a Program to illustrate Static member and methods

8. Write a Program to illustrate Bit fields

9. Write a Program to overload as binary operator, friend and member function

10. Write a Program to overload unary operator in Postfix and Prefix form as member and friend function

11. Write a C++ Program to illustrate Iterators and Containers

12. Write a C++ Program to illustrate function templates

13. Write a C++ Program to illustrate template class

14. Write C++ Programs and incorporating various forms of Inheritance

15. Write a C++ Program to illustrate Virtual functions

16. To write a C++ program to find the sum for the given variables using function with default arguments.

17. To write a C++ program to find the value of a number raised to its power that demonstrates a function using call by value.

18. To write a C++ program and to implement the concept of Call by Address

19. To write a program in C++ to prepare a student Record using class and object

20. To implement the concept of unary operator overloading by creating a C++ program.

21. Write a C++ program for swapping two values using function templates

22. Write a C++ program to implement a file handling concept using sequential access.

OUTCOMES:

- Explain what constitutes an object-oriented approach to programming and identify potentialbenefits of object-oriented programming over other approaches.
- Apply an object-oriented approach to developing applications of varying complexities

VLSI DESIGN

Objectives:

The main objectives of this course are:

- Basic characteristics of MOS transistor and examines various possibilities for configuring inverter circuits and aspects of latch-up are considered.
- Design processes are aided by simple concepts such as stick and symbolic diagrams but the key element is a set of design rules, which are explained clearly.
- Basic circuit concepts are introduced for MOS processes we can set out approximate circuit parameters which greatly ease the design process.

Outcomes:

At the end of this course the student can able to:

- Understand the properties of MOS active devices and simple circuits configured when using them and the reason for such encumbrances as ratio rules by which circuits can be interconnected in silicon.
- Know three sets of design rules with which nMOS and CMOS designs may be fabricated.
- Understand the scaling factors determining the characteristics and performance of MOS circuits in silicon.

Syllabus:

Unit-I:

Introduction and Basic Electrical Properties of MOS Circuits: Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. I_{ds} versus V_{ds} Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology. **(Text Book-1)**

Unit-II:

MOS and Bi-CMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams-Translation to Mask Form.

(Text Book-1)

Unit-III:

Basic Circuit Concepts: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, Some area Capacitance Calculations, The Delay Unit, Inverter Delays, Driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.

Scaling of MOS Circuits: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

(Text Book-1)

Unit-IV:

Chip Input and Output circuits: ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip clock Generation and Distribution.

Design for Testability: Fault types and Models, Controllability and Observability, Ad Hoc Testable Design Techniques, Scan Based Techniques and Built-In Self Test techniques.

(Text Book-2)

Unit-V:

FPGA Design: FPGA design flow, Basic FPGA architecture, FPGA Technologies, FPGA families- Altera Flex 8000FPGA, Altera Flex 10FPGA, Xilinx XC4000 series FPGA, Xilinx Spartan XL FPGA, Xilinx Spartan II FPGAs, Xilinx Vertex FPGA. Case studies: FPGA Implementation of Half adder and full adder.

Introduction to synthesis: Logic synthesis, RTL synthesis, High level Synthesis.

(Reference Text Book-1)

Unit-VI:

Introduction to Low Power VLSI Design: Introduction to Deep submicron digital IC design**,** Low Power CMOS Logic Circuits: Over view of power consumption, Low –power design through voltage scaling, Estimation and optimisation of switching activity, Reduction of switching capacitance. Interconnect Design, Power Grid and Clock Design.

(Text Book-2)

Text Books:

1. Essentials of VLSI Circuits and Systems - Kamran Eshraghian, Douglas and A. Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. CMOS Digital Integrated Circuits Analysis and Design- Sung-Mo Kang, Yusuf Leblebici, Tata McGraw-Hill Education, 2003.

References:

1. Advanced Digital Design with the Verilog HDL, Michael D.Ciletti, Xilinx Design Series, Pearson Education
2. Analysis and Design of Digital Integrated Circuits in Deep submicron Technology, 3’rd edition, David Hodges.

ROBOTICS
(Open Elective)

OBJECTIVES:

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their
  applications in robots and programming of robots.
- To discuss about the various applications of robots, justification and implementation of robot.

UNIT- I:
Introduction
Specifications of Robots- Classifications of robots – Work envelope - Flexible automation versus Robotic technology – Applications of Robots ROBOT KINEMATICS AND DYNAMICS Positions,

UNIT-II:
Orientations and frames, Mappings
Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic - D-H Representation - Forward and inverse Kinematics Of Six Degree of Freedom Robot Arm – Robot Arm dynamics

UNIT- III:
Robot Drives and Power Transmission Systems
Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives, Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws,

UNIT -IV:
Manipulators
Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators

UNIT- V:
Robot End Effectors
Classification of End effectors – Tools as end effectors. Drive system for grippers-Mechanical adhesive-vacuum-magnetic-grippers. Hooks&scoops. Gripper force analysis and gripper design. Active and passive grippers.

UNIT -VI:
Path planning & Programming
Trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion-Robot languages-computer control and Robot software.

OUTCOMES:

- The Student must be able to design automatic manufacturing cells with robotic control using
- The principle behind robotic drive system, end effectors, sensor, machine vision robot Kinematics and programming.

TEXT BOOKS:

1. Deb S. R. and Deb S., “Robotics Technology and Flexible Automation”, Tata McGraw HillEducation Pvt. Ltd, 2010.
2. John J.Craig, “Introduction to Robotics”, Pearson, 2009.
3. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.

REFERENCE BOOKS:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987

NEURAL NETWORKS AND FUZZY LOGIC
(Open Elective)

Preamble:
This course introduces the basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks. Also deals with Associate Memories and introducesFuzzy sets and Fuzzy Logic system components. The Neural Network and Fuzzy Network system application to Electrical Engineering is also presented. This subject is very important and useful for doing Project Work.

Learning Objectives:
- To understand artificial neuron models.
- To understand learning methods of ANN.
- To utilize different algorithms of ANN.
- To distinguish between classical and fuzzy sets.
- To understand different modules of fuzzy controller.
- To understand applications of neural networks and fuzzy logic.

Unit – I: Introduction to Neural Networks
Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential, Applications of ANN.

Unit- II: Essentials of Artificial Neural Networks
Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANNArchitectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application

Unit–III:
Multilayer feed forward Neural Networks
Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements, Radial Basis Function (RBF) Neural Network – Kohonen Self Organising feature Map (KSOM).
Associative Memories
Bidirectional Associative Memories (BAM)-Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network, Summary and Discussion of Instance/Memory Based Learning Algorithms, Applications.

Unit – IV: Classical & Fuzzy Sets
Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT V: Fuzzy Logic Modules
Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

UNIT VI: Applications
Neural network applications: Process identification, control, fault diagnosis and load forecasting.
Fuzzy logic applications: Load frequency control and Fuzzy classification.

Learning Outcomes:
Students should able to:

- Know different models of artificial neuron.
- Use learning methods of ANN.
- Use different paradigms of ANN.
- Classify between classical and fuzzy sets.
- Use different modules of Fuzzy logic controller.
- Apply Neural Networks and fuzzy logic for real-time applications.

Text Book:
1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandRai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH,2006

Reference Book:
1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.

ENERGY AUDIT, CONSERVATION & MANAGEMENT
(Open Elective)

Preamble:

This is an open elective course developed to cater the current needs of the industry. This course covers topics such as energy conservation act and energy conservation. It also covers energy efficient lighting design. The student will learn power factor improvement techniques, energy efficiency in HVAC systems. In addition The economic aspects such as payback period calculations, life cycle costing analysis is covered in this course.

Learning Objectives:

- To understand energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Unit–I:
Basic Principles of Energy Audit and management

Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top management.

Unit–II:
Lighting

Modification of existing systems – Replacement of existing systems – Priorities**:** Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Energy conservation measures.

Unit–III:
Power Factor and energy instruments

Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters – Tong testers – Power analyzer.

Unit–IV:
Space Heating and Ventilation

Ventilation – Air–Conditioning (HVAC) and Water Heating**:** Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–Cooling load – Electric water heating systems – Energy conservation methods.

Unit–V
Economic Aspects and Financial Analysis

Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.

Unit–VI:

Computation of Economic Aspects

Need of investment, appraisal and criteria - Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Power factor correction – Lighting – Applications of life cycle costing analysis – Return on investment – Numerical examples.

Learning Outcomes:

Student will be able to

- Explain energy efficiency, conservation and various technologies.
- Design energy efficient lighting systems.
- Calculate power factor of systems and propose suitable compensation techniques.
- Explain energy conservation in HVAC systems.
- Calculate life cycle costing analysis and return on investment on energy efficient technologies.

Text Books:

1. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

Reference Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
4. Energy management hand book by W.C.Turner, John wiley and sons.
5. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
6. http://www.energymanagertraining.com/download/Gazette_of_IndiaPartIISecI-37_25-08-2010.pdf

III Year – II SEMESTER

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POWER ELECTRONICS LAB

Learning objectives:

- To study the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
- To analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
- To understand the operation of AC voltage regulator with resistive and inductive loads.
- To understand the working of Buck converter, Boost converter and inverters.

Any 10 of the Following Experiments are to be conducted

1. Study of Characteristics of Thyristor, MOSFET & IGBT.
2. Design and development of a firing circuit for Thyristor.
3. Design and development of gate drive circuits for IGBT.
4. Single -Phase Half controlled converter with R and RL load
5. Single -Phase fully controlled bridge converter with R and RL loads
6. Single -Phase AC Voltage Regulator with R and RL Loads
7. Single -Phase square wave bridge inverter with R and RL Loads
8. Three- Phase fully controlled converter with RL–load.
9. Design and verification of voltages gain of Boost converter in Continuous Conduction Mode(CCM) and Discontinuous Conduction Mode(DCM).
10. Design and verification of voltages ripple in buck converter in CCM operation.
11. Single -phase PWM inverter with sine triangle PWM technique.
12. 3-phase AC-AC voltage regulator with R-load.

Learning outcomes:

- Able to study the characteristics of various power electronic devices and analyze gate drive circuits of IGBT.
- Able to analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
- Able to understand the operation of single phase AC voltage regulator with resistive and inductive loads.
- Able to understand the working of Buck converter, Boost converter, single–phase square wave inverter and PWM inverter.

III Year – II SEMESTER

L	T	P	C
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MICRO MPROCESSORS AND MICRO CONTROLLERS LAB

Learning Objectives:

- To study programming based on 8086 microprocessor and 8051 microcontroller.
- To study 8086 microprocessor based ALP using arithmetic, logical and shift operations.
- To study to interface 8086 with I/O and other devices.
- To study parallel and serial communication using 8051& PIC 18 micro controllers.

Any 10 of the following experiments are to be conducted:

I. Microprocessor 8086&Microcontroller 8051

Introduction to MASM/TASM.

1. Arithmetic operation – Multi byte addition and subtraction, multiplication and division – Signed and unsigned arithmetic operation, ASCII – Arithmetic operation.
2. Logic operations – Shift and rotate – Converting packed BCD to unpacked BCD, BCD to ASCII conversion.
3. By using string operation and Instruction prefix**:** Move block, Reverse string Sorting, Inserting, Deleting, Length of the string, String comparison.
4. Interfacing 8255–PPI
5. Interfacing 8259 – Interrupt Controller.
6. Interfacing 8279 – Keyboard Display.
7. Stepper motor control using 8253/8255.
8. Reading and Writing on a parallel port using 8051
9. Timer in different modes using 8051
10. Serial communication implementation using 8051
11. Understanding three memory areas of 00 – FF Using 8051 external interrupts.
12. Interface PIC 18 with an optoisolator
13. Interface PIC 18 with a DC motor

Learning Outcomes:

- Will be able to write assembly language program using 8086 micro based on arithmetic, logical, and shift operations.
- Will be able to interface 8086 with I/O and other devices.
- Will be able to do parallel and serial communication using 8051 & PIC 18 micro controllers.

III Year–II SEMESTER

L	T	P	C
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DATASTRUCTURES THROUGH C LAB

OBJECTIVES:

- To develop skills to design and analyze simple linear and non linear data structures
- To Strengthen the ability to identify and apply the suitable data structure for the given real world problem
- To Gain knowledge in practical applications of data structures

List of Experiments:

1. Implementation of Singly linked list.
2. Implementation of Doubly linked list.
3. Implementation of Multistack in a Single Array.
4. Implementation of Circular Queue
5. Implementation of Binary Search trees.
6. Implementation of Hash table.
7. Implementation of Heaps.
8. Implementation of Breadth First Search Techniques.
9. Implementation of Depth First Search Techniques.
10. Implementation of Prim's Algorithm.
11. Implementation of Dijkstra's Algorithm.
12. Implementation of Kruskal's Algorithm
13. Implementation of MergeSort
14. Implementation of Quick Sort
15. Implementation of Data Searching using divides and conquers technique

OUTCOMES:

At the end of this lab session, the student will

- Be able to design and analyze the time and space efficiency of the data structure
- Be capable to identity the appropriate data structure for given problem
- Have practical knowledge on the application of data structures

III Year - II Semester

L	T	P	C
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PROFESSIONAL ETHICSAND HUMAN VALUES

Course Objectives:

***To give basic insights and inputs to the student to inculcate Human values to grow as a responsible human beings with proper personality.**
***Professional Ethics instills the student to maintain ethical conduct and discharge their professional duties.**

UNIT I: Human Values:
Morals, Values and Ethics – Integrity –Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self-confidence – Spirituality- Character.

UNIT: II: Principles for Harmony:
Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

UNIT III: Engineering Ethics and Social Experimentation:
History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg's Theory - Gilligan's Argument –Heinz's Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering.

UNIT IV: Engineers' Responsibilities towards Safety and Risk:
Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/sInvoluntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects - Threshold Levels of Risk - Delayed v/sImmediate Risk - Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis-Accidents.

UNIT V: Engineers' Duties and Rights:
Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights – Confidential and Proprietary Information - Conflict of Interest-Ethical egoism - Collective Bargaining – Confidentiality - Gifts and Bribes - Problem solving-Occupational Crimes-Industrial Espionage- Price Fixing-Whistle Blowing.

UNIT VI: Global Issues:

Globalization and MNCs –Cross Culture Issues - Business Ethics – Media Ethics - Environmental Ethics – Endangering Lives - Bio Ethics - Computer Ethics - War Ethics – Research Ethics -Intellectual Property Rights.

- Related Cases Shall be dealt where ever necessary.

Outcome:

***It gives a comprehensive understanding of a variety issues that are encountered by every professional in discharging professional duties.**

***It provides the student the sensitivity and global outlook in the contemporary world to fulfill the professional obligations effectively.**

References:

1. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
2. Ethics in Engineering by Mike W. Martin and Roland Schinzinger - Tata McGraw-Hill – 2003.
3. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana - Maruthi Publications.
4. Engineering Ethics by Harris, Pritchard and Rabins, Cengage Learning, New Delhi.
5. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
6. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd – 2009.
7. Professional Ethics and Human Values by A. Alavudeen, R.Kalil Rahman and M. Jayakumaran – University Science Press.
8. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill - 2013
9. Human Values And Professional Ethics by Jayshree Suresh and B. S. Raghavan, S.Chand Publications

IV Year – I SEMESTER

L	T	P	C
4	0	0	3

UTILIZATION OF ELECTRICAL ENERGY

Preamble:

This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives. Another major share of loads is taken by Electric Traction. Utilization of electrical energy in all the above loads is discussed in detail in this course. Demand side management concepts are also introduced as a part of this course.

Learning objectives:

- To understand the operating principles and characteristics of traction motors with respect to speed, temperature,loading conditions.
- To acquaint with the different types of heating and welding techniques.
- To study the basic principles of illumination and its measurement.
- To understand different types of lightning system including design.
- To understand the basic principle of electric traction including speed–time curves of different traction services.
- To understand the method of calculation of various traction system for braking, acceleration and other related parameters, including demand side management of energy.

UNIT – I:

Selection of Motors

Choice of motor, type of electric drives, starting and running characteristics–Speed control–Temperature rise–Applications of electric drives–Types of industrial loads–continuous–Intermittent and variable loads–Load equalization.

UNIT – II:

Electric Heating

Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating – Arc furnaces – Direct and indirect arc furnaces

Electric Welding

Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding

UNIT – III:

Illumination fundamentals

Introduction, terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter–Discharge lamps, MV and SV lamps – Lumen or flux method of calculation - Sources of light.

UNIT – IV:

Various Illumination Methods

Comparison between tungsten filament lamps and fluorescent tubes–Basic principles of light control– Types and design of lighting and flood lighting–LED lighting, principle of operation, street lighting and domestic lighting – Conservation of energy.

UNIT – V:

Electric Traction – I

System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves-High speed transportation trains.

UNIT – VI:

Electric Traction – II

Calculations of tractive effort– power –Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking, retardation adhesive weight and coefficient of adhesion–Principles of energy efficient motors-Modern traction motors.

Learning Outcomes:

- Able to identify a suitable motor for electric drives and industrial applications
- Able to identify most appropriate heating or welding techniques for suitable applications.
- Able to understand various level of illuminosity produced by different illuminating sources.
- Able to estimate the illumination levels produced by various sources and recommend the most efficient illuminating sources and should be able to design different lighting systems by taking inputs and constraints in view.
- Able to determine the speed/time characteristics of different types of traction motors.
- Able to estimate energy consumption levels at various modes of operation.

Text Books:

1. Utilization of Electric Energy – by E. Openshaw Taylor, Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab, DhanpatRai& Sons.

Reference Books:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.

IV Year – I SEMESTER

L	T	P	C
4	0	0	3

LINEAR IC APPLICATIONS

OBJECTIVES

- To understand the basic operation &performance parameters of differential amplifiers.
- To understand & learn the measuring techniques of performance parameters of OP-AMP
- To learn the linear and non-linear applications of operational amplifiers.
- To understand the analysis & design of different types of active filters using opamps
- To learn the internal structure, operation and applications of different analog ICs
- To Acquire skills required for designing and testing integrated circuits

UNIT I

INTEGRATED CIRCUITS: Differential Amplifier- DC and AC analysis of Dual input Balanced output Configuration, Properties of other differential amplifier configuration (Dual Input Unbalanced Output, Single Ended Input – Balanced/ Unbalanced Output), DC Coupling and Cascade Differential Amplifier Stages, Level translator.

UNIT II

Characteristics of OP-Amps, Integrated circuits-Types, Classification, Package Types and Temperature ranges, Power supplies, Op-amp Block Diagram, ideal and practical Op-amp Specifications, DC and AC characteristics, 741 op-amp & its features, Op-Amp parameters & Measurement, Input & Out put Off set voltages & currents, slew rate, CMRR, PSRR, drift, Frequency Compensation techniques.

UNIT III

LINEAR and NON-LINEAR APPLICATIONS OF OP-AMPS: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non- Linear function generation, Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti log Amplifiers, Precision rectifiers.

UNIT IV

ACTIVE FILTERS, ANALOG MULTIPLIERS AND MODULATORS: Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.
Four Quadrant Multiplier, IC 1496, Sample & Hold circuits.

UNIT V

TIMERS & PHASE LOCKED LOOPS: Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger; PLL - introduction, block schematic, principles and description of individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation, AM, FM & FSK demodulators. Applications of VCO (566).

UNIT VI

DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC.DAC and ADC Specifications, Specifications AD 574 (12 bit ADC).

TEXT BOOKS:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3.Operational Amplifiers–C.G. Clayton, Butterworth & Company Publ. Ltd./Elsevier, 1971

REFERENCES :

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma ;SK Kataria &Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.
3. OP AMPS and Linear Integrated Circuits concepts and Applications, James M Fiore, Cenage Learning India Ltd.
4. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin & Fredrick Driscoll, PHI, 6th Edition.
5. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition

OUTCOMES

- Design circuits using operational amplifiers for various applications.
- Analyze and design amplifiers and active filters using Op-amp.
- Diagnose and trouble-shoot linear electronic circuits.
- Understand the gain-bandwidth concept and frequency response of the amplifier configurations.
- Understand thoroughly the operational amplifiers with linear integrated circuits.

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IV Year – I SEMESTER	**4**	**0**	**0**	**3**

POWER SYSTEM OPERATION AND CONTROL

Preamble:

This subject deals with Economic operation of Power Systems, Hydrothermal scheduling and modeling of turbines, generators and automatic controllers. It emphasizes on single area and two area load frequency control and reactive power control.

Learning Objectives:

- To understand optimal dispatch of generation with and without losses.
- To study the optimal scheduling of hydro thermal systems.
- To study the optimal unit commitment problem.
- To study the load frequency control for single area system with and without controllers
- .To study the load frequency control for two area system with and without controllers
- To understand the reactive power control and compensation of transmission lines.

UNIT–I:

Economic Operation of Power Systems

Optimal operation of Generators in Thermal power stations, – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

UNIT–II:

Hydrothermal Scheduling

Optimal scheduling of Hydrothermal System**:** Hydroelectric power plant models – Scheduling problems – Short term hydrothermal scheduling problem.

UNIT–III:

Unit Commitment

Optimal unit commitment problem – Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming.

UNIT–IV:

Load Frequency Control-I

Modeling of steam turbine – Generator – Mathematical modeling of speed governing system – Transfer function – Modeling of Hydro turbine –Necessity of keeping frequency constant – Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

UNIT–V:

Load Frequency Control-II

Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case. Tie-line bias control. Load Frequency Control and Economic dispatch control.

UNIT–VI:

Reactive Power Control

Overview of Reactive Power control – Reactive Power compensation in transmission systems – Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – Uncompensated and compensated transmission lines**:** Shunt and series compensation – Need for FACTS controllers.

Learning Outcomes:

- Able to compute optimal scheduling of Generators.
- Able to understand hydrothermal scheduling.
- Understand the unit commitment problem.
- Able to understand importance of the frequency.
- Understand importance of PID controllers in single area and two area systems.
- Will understand reactive power control and compensation for transmission line.

Text Books:

1. Electric Energy systems Theory – by O.I.Elgerd, Tata McGraw–hill Publishing Company Ltd., Second edition.
2. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata McGraw Hill Publishing Company Ltd, 2nd edition.

Reference Books:

1. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., Thompson, 3rd Edition.
2. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
3. Power System Analysis by HadiSaadat – TMH Edition.
4. Power System stability & control, PrabhaKundur,TMH

IV Year – I SEMESTER

L	T	P	C
4	0	0	3

SWITCHGEAR AND PROTECTION

Preamble:

In order to supply power from generating end to receiving end several equipments are connected in to the system. In order to protect the equipments and components against various operating conditions and over voltages protective devices are required to be installed in the system. Topics specified in this subject deal with various types of protective equipments and their working principle including limitations etc.

Learning objectives:

- To provide the basic principles and operation of various types of circuit breakers.
- To study the classification, operation and application of different types of electromagnetic protective relays.
- To explain protective schemes, for generator and transformers.
- To impart knowledge of various protective schemes used for feeders and bus bars.
- To explain the principle and operation of different types of static relays.
- To study different types of over voltages in a power system and principles of different protective schemes for insulation co–ordination.

UNIT–I:

Circuit Breakers

Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Introduction to oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Concept of Auto reclosing.

UNIT–II:

Electromagnetic Protection

Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays**:** Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**:** Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

UNIT–III:

Generator Protection

Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.

Transformer Protection

Protection of transformers**:** Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

UNIT–IV:

Feeder and Bus bar Protection

Protection of lines**:** Over currentProtection schemes – PSM,TMS - Numerical examples - Carrier current and three zone distance relay using impedance relays–Protection of bus bars by using Differential protection.

UNIT–V:

Static and Digital Relays

Static relays**:** Static relay components– Static over current relays– Static distance relay– Micro processor based digital relays

UNIT–VI:

Protection against over voltage and grounding

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters– Insulation coordination– BIL– impulse ratio– Standard impulse test wave– volt-time characteristics– Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding**:** Solid–resistance–Reactance–Arcing grounds and grounding Practices.

Learning Outcomes:

- Able to understand the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF_6 gas type.
- Ability to understand the working principle and operation of different types of electromagnetic protective relays.
- Students acquire knowledge of faults and protective schemes for high power generator and transformers.
- Improves the ability to understand various types of protective schemes used for feeders and bus bar protection.
- Able to understand different types of static relays and their applications.
- Able to understand different types of over voltages and protective schemes required for insulation co–ordination.

Text Books:

1. Power System Protection and Switchgear by Badari Ram and D.N Viswakarma, TMH Publications
2. Power system protection- Static Relays with microprocessor applications.by T.S.MadhavaRao,TMH

Reference Books:

1.Fundamentals of Power System Protection by Paithankar and S.R.Bhide.,PHI, 2003.
2. Art & Science of Protective Relaying – by C R Mason, Wiley Eastern Ltd.
3. Protection and SwitchGear by BhaveshBhalja, R.P. Maheshwari, NileshG.Chothani, Oxford University Press, 2013

IV Year – I SEMESTER

L	T	P	C
4	0	0	3

ELECTRICAL MACHINE MODELING & ANALYSIS
(Elective-I)

Preamble:
Electrical Motor is one of the main components of electrical drive. So, in order to develop control strategies for electrical motor drives, it is very essential to have complete knowledge on modeling of electrical machines.

Learning Objectives

- Establish unified theory of rotating machines.
- To understand the concept of phase transformation.
- Analyze different electrical machines for improved performance through modification of their characteristics.
- Develop concepts on mathematical modeling of electrical machines.

UNIT – I
Basic concepts of Modeling
Basic Two-pole Machine representationof Commutator machines, 3-phase synchronous machine with andwithout damper bars and 3-phase induction machine, Kron's primitiveMachine-voltage, current and Torque equations.

UNIT – II
DC Machine Modeling
Mathematical model of separately excited D.Cmotor – Steady State analysis-Transient State analysis-Suddenapplication of Inertia Load-Transfer function of Separately excited D.C Motor- Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations.

UNIT- III
Reference frame theory & Modeling of single phase InductionMachines
Linear transformation-Phase transformation - three phase totwo phase transformation (abc to dq0) and two phase to three phasetransformation dq0 to abc -Power equivalence-Mathematical modelingof single phase induction machines.

UNIT – IV
Modeling of three phase Induction Machine
Generalized model inarbitrary reference frame-Electromagnetic torque-Derivation ofcommonly used Induction machine models- Stator reference framemodel-Rotor reference frame model-Synchronously rotating referenceframe model-state space model with flux linkages as variables.

UNIT –V
Modeling of Synchronous Machine
Synchronous machine inductances–voltage equations in the rotor's dq0 reference frame-electromagnetictorque-current in terms of flux linkages-three synchronous machinemodel.

UNIT –IV

Modeling of Special Machines

Modeling of PM Synchronous motor, modeling of BLDC motor,modeling of Switched Reluctance motor.

Learning Outcomes:

After completion of this course, students will be able to

- Develop modeling of dc machine
- Apply mathematical modeling concepts to 3-phase Induction machines
- Design control strategies based on dynamic modeling of 3-ph Induction machines and 3-phase synchronous machine.
- Analyze BLDC Machine and switched reluctance machine based on mathematical modeling of BLDCM and SRM.

Text Books:

1. Generalized theory of Electrical Machinery –P.S.Bimbra- Khanna Publishers.
2. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications- 1st edition -2002.

Reference Books:

1. Analysis of Electrical Machinery and Drive systems – P.C.Krause, OlegWasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press.
2. Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng-PHl.
3. Modern Power Electronics and AC Drives-B.K. Bose - PHI

ADVANCED CONTROL SYSTEMS

Preamble:

This subject aims to study state space, describing function, phase plane and stability analysis including controllability and observability. It also deals with modern control and optimal control systems.

Learning Objectives:

- Review of the state space representation of a control system**:** Formulation of different models from the signal flow graph, diagonalization.
- To introduce the concept of controllability and observability. Design by pole placement technique.
- Analysis of a nonlinear system using Describing function approach and Phase plane analysis.
- The Lypanov's method of stability analysis of a system.
- Formulation of Euler Laugrange equation for the optimization of typical functionals and solutions.
- Formulation of linear quadratic optimal regulator (LQR) problem by parameter adjustment and solving riccatti equation.

UNIT – I:
State space analysis
State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

UNIT – II:
Controllability, observability and design of pole placement
Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality – Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.

UNIT – III:
Describing function analysis
Introduction to nonlinear systems, Types of nonlinearities, describing functions, Introduction to phase–plane analysis.

UNIT–IV:
Stability analysis
Stability in the sense of Lyapunov – Lyapunov's stability and Lypanov's instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

UNIT–V:
Calculus of variations
Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation.

UNIT –VI:

Optimal control

Linear Quadratic Optimal Regulator (LQR) problem formulation – Optimal regulator design by parameter adjustment (Lyapunov method) – Optimal regulator design by Continuous Time Algebraic Riccatti equation (CARE) - Optimal controller design using LQG framework.

Learning Outcomes:

- State space representation of control system and formulation of different state models are reviewed.
- Able to design of control system using the pole placement technique is given after introducing the concept of controllability and observability.
- Able to analyse of nonlinear system using the describing function technique and phase plane analysis.
- Able to analysethe stability analysis using lypnov method.
- Minimization of functionals using calculus of variation studied.
- Able to formulate andsolve the LQR problem and riccatti equation.

Text Books:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication

Reference Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition,1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata McGraw–Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS

Preamble:IN most of the industry applications, computer control is gaining importance, PLC is a industry computer, hence this course PLC makes the students to acquire knowledge required for industry.

Learning Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

Unit I:
Introduction
PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Unit II:
PLC Programming
PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams and sequence listings, ladder diagram construction.

Unit III:
Programmable Timers and Counters
Timer instructions – On delay time instruction – Off delay timer instruction – Retentive timer – Counter instructions – Up counter – Down counter - Cascading counters - Incremental encoder – Counter applications – Combining counter and timer functions.

Unit IV:
Program Control Instructions
Master control reset instruction – Jump instructions and sub routines – Immediate input and output instructions.

Unit V:
Other Instructions
Data manipulation – Data transfer operation – Data compare instruction – Data manipulation programs – Numerical data I/O interfaces – Math instructions – Addition, subtraction, multiplication & division instruction – Sequential instructions – Sequence programs – Shift registers – Word shift registers.

Unit VI:
Applications
Control of water level indicator – Alarm monitor - Conveyor motor control – Parking garage – Ladder diagram for process control – PID controller.

LearningOutcomes: After completion of the course, students are able to:

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic.
- Manage PLC registers for effective utilization in different applications.
- Design PID controller with PLC.

Text Books:

1. Programmable logic controllers by Frank D.Petruzella- McGraw Hill – 3rd Edition.
2. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI

Reference Books:

1. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
2. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
3. Programmable Logic Controllers –W.Bolton-Elsevier publisher

INSTRUMENTATION
(Elective – I)

Preamble:

Electrical and Electronic Instrumentation plays a key role in the industry. With the advancement of technology day to day manual maintenance is replaced by simply monitoring using various instruments. Thus this course plays very important role in overall maintenance of the industry.

Learning Objectives:

- To study various types of signals and their representation.
- To study various types of transducers: Electrical, Mechanical, Electromechanical, Optical etc.
- To study and measure the various types of Non–electrical quantities.
- To study various types of digital voltmeters
- To study the working principles of various types of oscilloscopes and their applications.
- To study various types of signal analyzers.

UNIT–I:

Signals and their representation

Measuring Systems, Performance Characteristics, – Static characteristics – Dynamic Characteristics – Errors in Measurement – Gross Errors – Systematic Errors – Statistical analysis of random errors – Signal and their representation – Standard test, periodic, aperiodic, modulated signal – Sampled data pulse modulation and pulse code modulation.

UNIT–II:

Transducers

Definition of transducers – Classification of transducers – Advantages of Electrical transducers – Characteristics and choice of transducers – Principle operation of resistor, inductor, LVDT and capacitor transducers – LVDT Applications – Strain gauge and its principle of operation – Guage factor – Thermistors – Thermocouples – Synchros – Piezo electric transducers – Photo diodes.

UNIT–III:

Measurement of Non–Electrical Quantities

Measurement of strain – Gauge Sensitivity – Displacement – Velocity – Angular Velocity – Acceleration – Force – Torque – Measurement of Temperature, Pressure, Vacuum, Flow, Liquid level.

UNIT–IV:

Digital Voltmeters

Digital voltmeters – Successive approximation, ramp, dual–Slope integration continuous balance type – Microprocessor based ramp type – DVM digital frequency meter – Digital phase angle meter.

UNIT–V:

Oscilloscope

Cathode ray oscilloscope – Time base generator – Horizantal and vertical amplifiers – Measurement of phase and frequency – Lissajous patterns – Sampling oscilloscope – Analog and digital type data logger – Transient recorder.

UNIT–VI:

Signal Analyzers

Wave Analyzers – Frequency selective analyzers – Heterodyne – Application of Wave analyzers – Harmonic Analyzers – Total Harmonic distortion – Spectrum analyzers – Basic spectrum analyzers – Spectral displays – Vector impedance meter – Q meter – Peak reading and RMS voltmeters.

Learning Outcomes:

- Able to represent various types of signals .
- Acquire proper knowledge to use various types of Transducers.
- Able to monitor and measure various parameters such as strain, velocity, temperature, pressure etc.
- Acquire proper knowledge and working principle of various types of digital voltmeters.
- Able to measure various parameter like phase and frequency of a signal with the help of CRO.
- Acquire proper knowledge and able to handle various types of signal analyzers.

Text Books:

1. Electronic Instrumentation–by H.S.Kalsi Tata MCGraw–Hill Edition, 1995.
2. A course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpatrai& Co.

Reference Books:

1. Measurement and Instrumentation theory and application, Alan S.Morris and Reza Langari, Elsevier
2. Measurements Systems, Applications and Design – by D O Doeblin
3. Principles of Measurement and Instrumentation – by A.S Morris, Pearson/ Prentice Hall ofIndia
4. Modern Electronic Instrumentation and Measurement techniques – by A.D HelfrickandW.D.Cooper, Pearson/Prentice Hall of India.

4. Transducers and Instrumentation by D.V.S Murthy, Prentice Hall of India.

IV Year – I SEMESTER

L	T	P	C
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OPTIMIZATION TECHNIQUES
(Elective – II)

Preamble:

Optimization techniques have gained importance to solve many engineering design problems by developing linear and nonlinear mathematical models. The aim of this course is to educate the student to develop a mathematical model by defining an objective function and constraints in terms of design variables and then apply a particular mathematical programming technique. This course covers classical optimization techniques, linear programming, nonlinear programming and Genetic & Partial Swarm Optimization algorithms.

Learning Objectives:

- To define an objective function and constraint functions in terms of design variables, and then state the optimization problem.
- To state single variable and multi variable optimization problems, without and with constraints.
- To explain linear programming technique to an optimization problem, define slack and surplus variables, by using Simplex method.
- To study and explain nonlinear programming techniques, unconstrained or constrained, and define exterior and interior penalty functions for optimization problems.
- To introduce evolutionary programming techniques.
- To introduce basic principles of Genetic Algorithms and Partial Swarm Optimization methods.

UNIT – I:

Introduction and Classical Optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

UNIT – II:

Classical Optimization Techniques

Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – III:

Linear Programming

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.

UNIT – IV:

Nonlinear Programming:

Unconstrained cases - One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method - Univariate method, Powell's method and steepest descent method.

Constrained cases - Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods.Introduction to convex Programming Problem.

UNIT – V:

Introduction to Evolutionary Methods:

Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters –Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function – constraints – Genetic algorithm steps – Stopping criteria –Simple examples.

UNIT – VI:

Introduction to Swarm Intelligence Systems:

Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method – Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO.

Learning Outcomes:

The student should be able to:

- State and formulate the optimization problem, without and with constraints, by using design variables from an engineering design problem.
- Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.
- Able to apply Genetic algorithms for simple electrical problems.
- Able to solve practical problems using PSO.

Text Books

1. "Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. Soft Computing with Matlab Programming by N.P.Padhy&S.P.Simson, Oxford University Press – 2015

Reference Books:

1. **"**Optimization methods in operations Research and Systems Analysis" by K.V.Mital and C.Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Genetic Algorithms in search, optimization, and Machine Learning by David E.Goldberg,ISBN:978-81-7758-829-3, Pearsonby Dorling Kindersley (India) Pvt. Ltd.
3. "Operations Research: An Introduction" by H.A.Taha, PHI pvt. Ltd., 6th edition.
4. Linear Programming by G.Hadley.

ELECTRIC POWER QUALITY

Preamble:

Power quality is a major problem for utilities and customers. Customers using sensitive critical loads need quality power for proper operation of the electrical equipment. It is important for the student to learn the power quality issues and improvement measures provided by the utility companies. This course covers the topics on voltage and current imperfections, harmonics, voltage regulation, power factor improvement, distributed generation, power quality monitoring and measurement equipment.

Learning Objectives:

- To learn different types of power quality phenomena.
- To identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
- To describe power quality terms and study power quality standards.
- To learn the principle of voltage regulation and power factor improvement methods.
- To explain the relationship between distributed generation and power quality.
- To understand the power quality monitoring concepts and the usage of measuring instruments.

Unit–I:Introduction

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations.

Unit–II:Voltage imperfections in power systems

Power quality terms – Voltage sags – Voltage swells and interruptions – Sources of voltage sag, swell and interruptions – Nonlinear loads – IEEE and IEC standards. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients.

Unit–III: Voltage Regulation and power factor improvement:

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

Unit– IV: Harmonic distortion and solutions

Voltagedistortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active filtering – Numerical problems.

Unit–V: Distributed Generation and Power Quality

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Unit–VI :Monitoring and Instrumentation

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

Learning Outcomes:

At the end of this course the student should be able to

- Differentiate between different types of power quality problems.
- Explain the sources of voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
- Analyze power quality terms and power quality standards.
- Explain the principle of voltage regulation and power factor improvement methods.
- Demonstrate the relationship between distributed generation and power quality.
- Explain the power quality monitoring concepts and the usage of measuring instruments.

Textbooks:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw–Hill, 2012, 3rd edition.
2.Electric power quality problems –M.H.J.Bollen IEEE series-Wiley India publications,2011.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw–Hill, 2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition, IEEE Press; 2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
5. Power Quality c.shankaran, CRC Press, 2001
6. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
7. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs, Mohammad A.S. Masoum–Elsevier.

SPECIAL ELECTRICAL MACHINES

Preamble:

This is an advanced course on electrical machines. Students will be exposed to various special machines which are gaining importance in industry. This course covers topics related to principles, performance and applications of these special machines including switched reluctance motors, stepper motors, permanent magnet dc motors and linear motors.

Learning Objective:

- To explain theory of operation and control of switched reluctance motor.
- To explain the performance and control of stepper motors, and their applications.
- To describe the operation and characteristics of permanent magnet dc motor.
- To distinguish between brush dc motor and brush less dc motor**.**
- To explain the theory of travelling magnetic field and applications of linear motors.

Unit I:

Permanent magnet materials and PMDC motors

Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor-Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-Temperature effects: reversible and irreversible losses-high temperature effects-reversible losses-Irreversible losses recoverable by magnetization-Mechanical properties, handling and magnetization-Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty.

Unit II:

Stepper Motors

Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) - Construction and principle of hybid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor.

Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stack – Open loop control of 3- phase VR Stepper Motor- Applications.

Unit III:

Switched Reluctance Motors

Construction – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.

Unit IV:

Square Wave Permanent Magnet Brushless DC Motor

Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor. Torque and EMF equations – Torque speed characteristics – Performance and efficiency- Square wave brushless motors with 120^0 and 180^0 magnetic areas commutation.

Unit V:

Sine wave Permanent Magnet Brushless Motor

Torque and EMF equations – Phasor Diagram – Circle diagram – Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors - Applications.

Unit VI:

Linear Induction Motors (LIM)

Construction– principle of operation–Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one sided LIM with back iron-equivalent circuit of LIM.

Learning Outcomes:

The student should be able to

- Distinguish between brush dc motor and brush less dc motor**.**
- Explain the performance and control of stepper motors, and their applications.
- Explain theory of operation and control of switched reluctance motor.
- Explain the theory of travelling magnetic field and applications of linear motors.
- Understand the significance of electrical motors for traction drives.

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi.

IV Year – I SEMESTER

L	T	P	C
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ELECTRICAL SIMULATION LAB

Learning objectives:

- To simulate integrator circuit, differentiator circuit, Boost converter, Buck converter, full convertor and PWM inverter.
- To simulate transmission line by incorporating line, load and transformer models.
- To perform transient analysis of RLC circuit and single machine connected to infinite bus(SMIB).

Following experiments are to be conducted:

1. Simulation of transient response of RLC circuits
   a. Response to pulse input
   b. Response to step input
   c. Response to sinusoidal input
2. Analysis of three phase circuit representing the generator transmission line and load. Plot three phase currents & neutral current .
3. Simulation of single–phase full converter using RLE loads and single phase AC voltage controller using RL loads
4. Plotting of Bode plots, root locus and nyquist plots for the transfer functions of systems up to 5^{th} order
5. Simulation of Boost and Buck converters.
6. Integrator & Differentiator circuits using op–amp.
7. Simulation of D.C separately excited motor using transfer function approach.

Any 2 of the following experiments are to be conducted:

1. Modeling of transformer and simulation of lossy transmission line.
2. Simulation of single phase inverter with PWM control.
3. Simulation of three phase full converter using MOSFET and IGBTs.
4. Transient analysis of single machine connected to infinite bus(SMIB).

Learning outcomes:

- Able to simulate integrator circuit, differentiator circuit, Boost converter, Buck converter, full convertor and PWM inverter.
- Able to simulate transmission line by incorporating line, load and transformer models.
- Able to perform transient analysis of RLC circuit and single machine connected to infinite bus(SMIB).

Reference Books:

1. "Simulation of Power Electronic Circuit",byM.B.patil, V.Ramanarayan, V.T.Ranganathan.Narosha,2009.
2. Pspice for circuits and electronics using PSPICE – by M.H.Rashid, M/s PHI Publications
3. Pspice A/D user`s manual – Microsim, USA
4. Pspice reference guide – Microsim, USA
5. MATLAB user`s manual – Mathworks, USA
6. MATLAB – control system tool box – Mathworks, USA
7. SIMULINK user`s manual – Mathworks, USA
8. EMTP User`s Manual.
9. SEQUEL– A public domain circuit simulator available at www.ee.iitb.ac.in/~sequel

IV Year – I SEMESTER

L	T	P	C
0	0	3	2

POWER SYSTEMS LAB

Learning Objectives:

To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Any 10 of the Following experiments are to be conducted:

1. Sequence impedances of 3 phase Transformer.
2. Sequence impedances of 3 phase Alternator by Fault Analysis.
3. Sequence impedances of 3 phase Alternator by Direct method.
4. ABCD parameters of Transmission line.
5. Power Angle Characteristics of 3phase Alternator with infinite bus bars.
6. Dielectric strength of Transformer oil.
7. Calibration of Tong Tester.
8 Load flow studies using Gauss-seidel method
9. Load flow studies using N-R method..
10. Transient Stability Analysis
11. Load frequency control with &without control
12. Load frequency control with control
13. Economic load dispatch with & without losses
14. Economic load dispatch with losses.

Learning Outcomes:

The student is able to determine the parameters of various power system components which are frequently occur in power system studies and he can execute energy management systems functions at load dispatch center.

IV Year – II SEMESTER

L	T	P	C
4	0	0	3

DIGITAL CONTROL SYSTEMS

Preamble:

In recent years digital controllers have become popular due to their capability of accurately performing complex computations at high speeds and versatility in leading nonlinear control systems. In this context, this course focuses on the analysis and design of digital control systems.

Learning objectives:

- To understand the concepts of digital control systems and assemble various components associated with it. Advantages compared to the analog type.
- The theory of z–transformations and application for the mathematical analysis of digital control systems.
- To represent the discrete–time systems in state–space model and evaluation of state transition matrix.
- To examine the stability of the system using different tests.
- To study the conventional method of analyzing digital control systems in the w–plane.
- To study the design of state feedback control by "the pole placement method."

UNIT – I:

Introduction and signal processing

Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Signals and processing – Sample and hold devices – Sampling theorem and data reconstruction – Frequency domain characteristics of zero order hold.

UNIT–II:

z–transformations

z–Transforms – Theorems – Finding inverse z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses.

UNIT–III:

State space analysis and the concepts of Controllability and observability

State space representation of discrete time systems – State transition matrix and methods of evaluation – Discretization of continuous – Time state equations – Concepts of controllability and observability – Tests(without proof).

UNIT – IV:

Stability analysis

Mapping between the s–Plane and the z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test.

UNIT – V:

Design of discrete–time control systems by conventional methods

Transient and steady state specifications – Design using frequency response in the w–plane for lag and lead compensators – Root locus technique in the z–plane.

UNIT – VI:

State feedback controllers:

Design of state feedback controller through pole placement – Necessary and sufficient conditions – Ackerman's formula.

Learning outcomes:

- The students learn the advantages of discrete time control systems and the "know how" of various associated accessories.
- The learner understand z–transformations and their role in the mathematical analysis of different systems(like Laplace transforms in analog systems).
- The stability criterion for digital systems and methods adopted for testing the same are explained.
- Finally, the conventional and state space methods of design are also introduced.

Text Book:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal, TMH, 4^{th} Edition.

Reference Books:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.

IV Year – II SEMESTER

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H.V.D.C. TRANSMISSION

Preamble:
This subject deals with the importance of HVDC transmission, analysis of HVDC converters, Faults and protections, Harmonics and Filters. It also deals with Reactive power control and Power factor improvements of the system.

Learning Objectives:

- To Understand basic concepts of HVDC Transmission.
- To analyze the converter configuration.
- To Know the control of converter and HVDC Transmission.
- To Understand the significance of reactive power control and AC/Dc load flow.
- To Know different converter faults, protection and effect of harmonics.
- To leave low pass and high pass filters.

UNIT – I
Basic Concepts
Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC Transmission, Application of DC Transmission System – Planning & Modern trends in D.C. Transmission.

UNIT – II
Analysis of HVDC Converters
Choice of converter configuration – analysis of Graetz – characteristics of 6 pulse & 12 pulse converters –Cases of two 3 phase converters in star –star mode – their performance.

UNIT – III
Converter & HVDC System Control
Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system - Starting and stopping of DC link - Power Control.

UNIT-IV
Reactive Power Control in HVDC
Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategiessources of reactive power-AC Filters – shunt capacitors-synchronous condensers.

Power Flow Analysis In AC/DC Systems
Modelling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC loadflow –solution of AC-DC Power flow-Simultaneous method-Sequential method.

UNIT-V
Converter Fault & Protection
Converter faults – protection against over current and over voltage in converter station – surge arresters –smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference.

Harmonics
Generation of Harmonics –Characteristics harmonics, calculation of AC Harmonics, Non-Characteristics harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics.

UNIT-VI

Filters

Types of AC filters,Design of Single tuned filters –Design of High pass filters.

Learning Outcomes:

The Student shall be able to

- Learn different types of HVDC levels and basic concepts
- Know the operation of converters
- Acquire control concept of reactive power control and AC/DC load flow.
- Understand converter faults, protection and harmonic effects
- Design low pass and high pass filters

Text Books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar,New Age International (P) Limited, and Publishers.
2. HVDC Transmission by S.Kamakshaiah andV.Kamaraju-Tata McGraw–Hill

Reference Books:

1. HVDC Transmission – J.Arrillaga.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications.

IV Year – II SEMESTER

L	T	P	C
4	0	0	3

ELECTRICAL DISTRIBUTION SYSTEMS

Preamble:

This subject deals with the general concept of distribution system, substations and feeders as well as discusses distribution system analysis, protection and coordination, voltage control and power factor improvement.

Learning Objectives

- To study different factors of Distribution system.
- To study and design the substations and distribution systems.
- To study the concepts of voltage drop and power loss.
- To study the distribution system protection and its coordination.
- To study the effect of compensation for power factor improvement.
- To study the effect of voltage control on distribution system.

UNIT – I:

General Concepts

Introduction to distribution systems, Load modeling and characteristics – Coincidence factor – Contribution factor loss factor – Relationship between the load factor and loss factor – Classification of loads (Residential, commercial, Agricultural and Industrial).

UNIT – II:

Substations

Location of substations**:** Rating of distribution substation – Service area with'n'primary feeders – Benefits and methods of optimal location of substations..

Distribution Feeders

Design Considerations of distribution feeders**:** Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT – III:

System Analysis

Voltage drop and power–loss calculations**:** Derivation for voltage drop and power loss in lines – Uniformly distributed loads and non-uniformly distributed loads – Numerical problems - Three phase balanced primary lines.

UNIT – IV:

Protection

Objectives of distribution system protection – Types of common faults and procedure for fault calculations for distribution system – Protective devices**:** Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers.

Coordination

Coordination of protective devices**:** General coordination procedure –Various types of co-ordinated operation of protective devices - Residual Current Circuit Breaker

UNIT – V:

Compensation for Power Factor Improvement

Capacitive compensation for powerfactor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location – Numerical problems.

UNIT – VI:

Voltage Control

Voltage Control**:** Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR – Line drop compensation – Numerical problems.

Learning Outcomes:

- Able to understand various factors of distribution system.
- Able to design the substation and feeders.
- Able to determine the voltage drop and power loss
- Able to understand the protection and its coordination.
- Able to understand the effect of compensation forp.f improvement.
- Able to understand the effect of voltage control.

Text Book:

1. "Electric Power Distribution system, Engineering" – by TuranGonen, McGraw–hill Book Company.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo, CRC press
2. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4^{th} edition, 1997.
3. Electrical Power Distribution Systems by V.Kamaraju, Right Publishers.

IV Year – II SEMESTER

L	T	P	C
4	0	0	3

HIGH VOLTAGE ENGINEERING
(ELECTIVE – III)

Preamble:

With the growth of power, HV power transmission has become an important subject. The performance of generating equipment requires knowledge of different phenomena occurring at higher voltage. Thus evaluations of various insulating materials are required for protection of HV equipments. Keeping this in view the course is designed to understand various phenomena related to breakdown study and withstand characteristics of insulating materials. The course also describes the generation and measurement of DC, AC and Impulse voltages as well various testing techniques.

Learning Objectives:

- To understand electric field distribution and computation in different configuration of electrode systems.
- To understand HV breakdown phenomena in gases, liquids and solids dielectrics.
- To acquaint with the generating principle of operation and design of HVDC, AC and Impulse voltages and currents.
- To understand various techniques of AC, DC and Impulse measurement of high voltages and currents.
- To understand the insulating characteristics of dielectric materials.
- To understand the various testing techniques of HV equipments.

UNIT–I:
Introduction to High Voltage Technology
Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation.

UNIT–II:
Break down phenomenon in gaseous, liquid and solid insulation
Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice.

UNIT–III:
Generation of High voltages and High currents
Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents – Tripping and control of impulse generators.

UNIT–IV:
Measurement of high voltages and High currents
Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.

UNIT–V:

Non–destructive testing of material and electrical apparatus

Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements.

UNIT–VI:

High voltage testing of electrical apparatus

Testing of insulators and bushings – Testing of isolators and circuit breakers – Testing of cables – Testing of transformers – Testing of surge arresters – Radio interference measurements.

Learning Outcomes:

- To be acquainted with the performance of high voltages with regard to different configurations of electrode systems.
- To be able to understand theory of breakdown and withstand phenomena of all types of dielectric materials.
- To acquaint with the techniques of generation of AC,DC and Impulse voltages.
- To be able to apply knowledge for measurement of high voltage and high current AC,DC and Impulse.
- To be in a position to measure dielectric property of material used for HV equipment.
- To know the techniques of testing various equipment's used in HV engineering.

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition.
2. High Voltage Engineering and Technology by Ryan, IET Publishers.

Reference Books:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
3. High Voltage Insulation Engineering by RavindraArora, Wolfgang Mosch, New Age International (P)Limited,1995.

FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEMS

Preamble:

Flexible Alternating Current Transmission System controllers have become a part of modern power system. It is important for the student to understand the principle of operation of series and shunt compensators by using power electronics. As the heart of many power electronic controllers is a voltage source converter (VSC), the student should be acquainted with the operation and control of VSC. Two modern power electronic controllers are also introduced.

Learning Objectives:

- To learn the basics of power flow control in transmission lines using FACTS controllers
- To explain operation and control of voltage source converter.
- To understand compensation methods to improve stability and reduce power oscillations of a power system.
- To learn the method of shunt compensation using static VAR compensators.
- To learn the methods of compensation using series compensators
- To explain operation of Unified Power Flow Controller (UPFC).

Unit–I:
Introduction to FACTS

Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers – Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

Unit–II:
Voltage source and Current source converters

Concept of voltage source converter(VSC) – Single phase bridge converter – Square–wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter– Three–phase current source converter – Comparison of current source converter with voltage source converter.

Unit–III:
Shunt Compensators–1

Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping.

Unit–IV:
Shunt Compensators–2

Thyristor Switched Capacitor(TSC)–Thyristor Switched Capacitor – Thyristor Switched Reactor (TSC–TCR). Static VAR compensator(SVC) and Static Compensator(STATCOM)**:** The regulation and slope transfer function and dynamic performance – Transient stability enhancement and power oscillation damping– Operating point control and summary of compensation control.

Unit V:

Series Compensators

Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC).

Unit–VI:

Combined Controllers

Schematic and basic operating principles of Unified Power Flow Controller (UPFC).– Application on transmission lines.

Learning Outcomes:

The student should be able to

- Understandpower flow control in transmission lines using FACTS controllers.
- Explain operation and control of voltage source converter.
- Analyze compensation methods to improve stability and reduce power oscillations in the transmission lines.
- Explain the method of shunt compensation using static VAR compensators.
- Understand the methods of compensations using series compensators.
- Explain operation of Unified Power Flow Controller (UPFC).

Text Books:

1. "Understanding FACTS" N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:—Standard Publications, 2001.

Reference Books:

1. "Flexible ac transmission system (FACTS)" Edited by Yong Hue Song and Allan T Johns, Institution of Electrical Engineers, London.
2. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R.MohanMathur and Rajiv k.Varma, Wiley

POWER SYSTEM REFORMS
(Elective III)

Preamble:

This course introduces the concepts and issues of power system reforms and aims at computation of Available Transfer Capability (ATC), Congestion Management, Electricity Pricing, Ancillary services Management and Power system operation in competitive environment

Learning Objectives:

- To study fundamentals of power system deregulation and restructuring.
- To study available transfer capability.
- To study congestion management
- To study various electricity pricing methods.
- To study operation of power system in deregulated environment.
- To study importance of Ancillary services management.

UNIT–I
Over view of key issues in electric utilities
Introduction – Restructuring models – Independent system operator (ISO) – Power Exchange – Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion.

UNIT–II
Available Transfer Capability (ATC)
Structure of OASIS – Processing of Information – Transfer capability on OASIS – Definitions Transfer Capability Issues – ATC – TTC – TRM – CBM calculations – Methodologies to calculate ATC.

UNIT–III
Congestion Management
Introduction to congestion management – Methods to relieve congestion

UNIT–IV
Electricity Pricing:
Introduction – Electricity price volatility electricity price indexes – Challenges to electricity pricing – Construction of forward price curves – Short–time price forecasting.

UNIT–V
Power system operation in competitive environment:
Introduction – Operational planning activities of ISO – The ISO in pool markets – The ISO in bilateral markets – Operational planning activities of a GENCO.

UNIT–VI
Ancillary Services Management:
Introduction – Reactive power as an ancillary service – A review – Synchronous generators as ancillary service providers.

Learning Outcomes:

- Will understand importance of power system deregulation and restructuring.
- Able to compute Available Transfer Capability**.**
- Will understand transmission congestion management.
- Able to compute electricity pricing in deregulated environment.
- Will be able to understand power system operation in deregulated environment.
- Will understand importance of ancillary services.

Text Books:

1. Kankar Bhattacharya, Math H.J. Boller, JaapE.Daalder, 'Operation of Restructured Power System' Kluver Academic Publisher – 2001.
2. Mohammad Shahidehpour, and Muwaffaqalomoush, – "Restructured electrical Power systems" Marcel Dekker, Inc. 2001

Reference Books:

1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon Wiley & Sons Ltd., England.
2. Electrical Power Distribution Case studies from Distribution reform, upgrades and Management (DRUM) Program, by USAID/India, TMH

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For

B.TECH – ELECTRICAL AND ELECTRONICS ENGINEERING

(Applicableforbatchesadmittedfrom2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

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I B.Tech – I SEMESTER

Sl. No	Course Components	Subjects	L	T	P	Credits
1	HSMC	Communicative English	3	0	0	3
2	BSC	Mathematics-I (Calculus and Differential Equations)	3	0	0	3
3	BSC	Mathematics-II **(**Linear Algebra and Numerical Methods**)**	3	0	0	3
4	ESC	Programming for Problem Solving Using C	3	0	0	3
5	ESC	Engineering Drawing & Design	1	0	4	3
6	HSMC	EnglishCommunicationSkillsLaboratory	0	0	3	1.5
7	BSC	Electrical Engineering Workshop	0	1	3	1.5
8	ESC	Programming for Problem Solving Using C Lab	0	0	3	1.5
		Total Credits				**19.5**

I B.Tech – II SEMESTER

Sl. No	Course Components	Subjects	L	T	P	Credits
1	BSC	Mathematics-III (Vector Calculus, Transforms and PDE)	3	0	0	3
2	BSC	Applied Physics	3	0	0	3
3	ESC	Data Structures Through C	3	0	0	3
4	ESC	Electrical Circuit Analysis-I	3	0	0	3
5	ESC	Basic Civil and Mechanical Engineering	3	0	0	3
6	BSC	Applied Physics Lab	0	0	3	1.5
7	ESC	Basic Civil and Mechanical Engineering Lab	0	0	3	1.5
8	ESC	Data Structures through C Lab	0	0	3	1.5
9	Mandatory Course	Constitution of India	2	0	0	0
		Total Credits				**19.5**

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II B.Tech – I Semester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	BSC	Mathematics– IV	3	0	0	3
2	PCC	Electronic Devices and Circuits	3	0	0	3
3	PCC	Electrical Circuit Analysis –II	3	0	0	3
4	PCC	DC Machines and Transformers	3	0	0	3
5	PCC	Electro Magnetic Fields	3	0	0	3
6	PCC	Electrical Circuits Lab	0	0	3	1.5
7	PCC	DC Machines and Transformers Lab	0	0	3	1.5
8	PCC	Electronic Devices and Circuits lab	0	0	3	1.5
9	SC	Skill oriented course - Design of Electrical Circuits using Engineering Software Tools	0	0	4	2
10	MC	Professional Ethics & Human Values	2	0	0	0
		Total Credits	**21.5**			

II B.Tech – II Semester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	ESC	Python Programming	3	0	0	3
2	PCC	Digital Electronics	3	0	0	3
3	PCC	Power System-I	3	0	0	3
4	PCC	Induction and Synchronous Machines	3	0	0	3
5	HSMC	Managerial Economics & Financial Analysis	3	0	0	3
6	ESC	Python Programming Lab	0	0	3	1.5
7	PCC	Induction and Synchronous Machines Lab	0	0	3	1.5
8	PCC	Digital Electronics Lab	0	0	3	1.5
9	SC	Skill oriented course- IoT Applications of Electrical Engineering Lab	0	0	4	2
		Total Credits	**21.5**			
		Minors Course*	4	0	0	4
		Honors Course*	4	0	0	4

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III B.Tech – I Semester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	PCC	Power Systems-II	3	0	0	3
2	PCC	Power Electronics	3	0	0	3
3	PCC	Control Systems	3	0	0	3
4	OEC	Open Elective- I/ Job Oriented Elective-I	3	0	0	3
5	PEC	Professional Elective - I	3	0	0	3
6	PCC	Control Systems Lab	0	0	3	1.5
7	PCC	Power Electronics Lab	0	0	3	1.5
8	SC	Soft Skill Course:Employability Skills	2	0	0	2
9	MC	Environmental Science	2	0	0	0
10	PROJ	Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester)	0	0	0	1.5
		TotalCredits	**21.5**			
		Minors Course*	4	0	0	4
		Honors Course*	4	0	0	4

III B.Tech – II Semester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	PCC	Microprocessors and Microcontrollers	3	0	0	3
2	PCC	Electrical Measurements and Instrumentation	3	0	0	3
3	PCC	Power System Analysis	3	0	0	3
4	PEC	Professional Elective - II	3	0	0	3
5	OEC	Open Elective –II/ Job Oriented Elective-II	3	0	0	3
6	PCC	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
7	PCC	Microprocessors and Microcontrollers Lab	0	0	3	1.5
8	PCC	Power Systems and Simulation Lab	0	0	3	1.5
9	SC	**Skill Advanced Course:** Machine Learning with Python	2	0	0	2
10	MC	Research Methodology	2	0	0	0
		Total Credits	**21.5**			
		Minors Course*	4	0	0	4
		Honors Course*	4	0	0	4

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IV B.Tech – I Semester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	PEC	Professional Elective – III	3	0	0	3
2	PEC	Professional Elective – IV	3	0	0	3
3	PEC	Professional Elective – V	3	0	0	3
4	OEC	Open Elective- III/Job Oriented Elective-III	3	0	0	3
5	OEC	Open Elective-IV /Job Oriented Elective-IV	3	0	0	3
6	HSMC	Universal Human Values-2: Understanding Harmony	3	0	0	3
7	SC	**Skill Advanced Course** Machine Learning with PythonLab	0	0	4	2
8	PROJ	Industrial / Research Internship 2 Months (Mandatory) after third year (to be evaluated during VII Semester)	0	0	3	3
		Total Credits	**23**			
		Minors Course*	4	0	0	4
		Honors Course*	4	0	0	4

IVB.TechIISemester

Sl. No	Course Components	Subjects	L	T	P	Credits
1	Major Project	Project work, seminar and internship in industry (6 Months)	--	--	--	12
		Total Credits	**12**			

HSMC:Humanities and Social Science Including Management Courses
BSC :Basic Science Courses
ESC:Engineering Science Courses
PCC:Professional Core Courses

PEC : Professional Elective Courses
OEC : Open Elective Courses
PROJ : Internship, Seminar, Project Wok
MC : Mandatory Courses
SC : Skill Oriented Courses

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Professional Elective Subjects offered to EEE Branch Students:

Professional Elective – I:

1. Linear IC Applications
2. Utilization of Electrical Energy
3. Computer Architecture and Organization
4. Optimization Techniques
5. Object Oriented Programming through Java

Professional Elective – II:

1. Signal and Systems
2. Electric Drives
3. Advanced Control Systems
4. Switchgear and Protection
5. Big Data Analytics

Professional Elective –III:

1. Digital Signal Processing
2. Renewable and Distributed Energy Technologies
3. Flexible Alternating Current Transmission Systems
4. Power Systems Deregulation
5. Data Base Management Systems

Professional Elective – IV:

1. Hybrid Electric Vehicles
2. High Voltage Engineering
3. Programmable Logic Controllers and Applications
4. Cloud Computing with AWS
5. Deep Learning Techniques

Professional Elective – V:

1. Power System Operation and Control
2. Switched Mode Power Conversion
3. AI Applications toElectrical Engineering
4. Data Science
5. MEAN Stack Technologies

Open Electives offered by EEE Department for Other Branches (Except EEE Branch)

Open Elective-I:

1. Renewable Energy Sources
2. Concepts of Optimization Techniques
3. Concepts of Control Systems

Open Elective-II:

1. Battery Management Systems and Charging Stations
2. Fundamentals of utilization of Electrical Energy
3. Indian Electricity Act

Open Elective-III:

1. Concepts of Microprocessors and Microcontrollers
2. Fundamentals of Electric Vehicles
3. Concepts of Internet of Things

Open Elective-IV:

1. Concepts of Power System Engineering
2. Concepts of Smart Grid Technologies

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*For Honor's/ Minor Course Fullfillments:

- The 20 additional Credits need to be acquired, 16/15 credits can be earned by undergoing specified courses listed as pools, with 4/5 courses, each carrying 4/3 credits. The remaining 4/5 credits must be acquired through two online MOOCs (Swayam /NPTEL), which shall be domain specific, with 2/3 credits and with a minimum duration of 8/12weeks as recommended by the Board of Studies.
- Minor Engineering subjects are offered to other branches by EEE Department (except for EEE Students).
- Honors Engineering subjects are offered to EEE Students.
- The head of the department will float the list of allowed MOOC electives in each academic year, based on the list floated by MOOCs (Swayam/NPTEL).

*Honors Engineering Courses offered EEE Branch students

II B.Tech II Semester:

1. Communication Systems
2. Electrical Wiring, Estimation and Costing
3. Electrical Distribution Systems

III B.Tech I Semester:

1. Advanced Computer Networks
2. Power Quality
3. Special Electrical Machines

III B.Tech II Semester:

1. Digital Control Systems
2. Analysis of Power Electronic Converters
3. HVDC Transmission

IV B.Tech I Semester:

1. EHV AC Transmission
2. Smart Grid Technologies
3. Power Electronic Control of Electrical Drives

*Minor Engineering Courses offered by EEE Department for Other Branches (Except EEE Branch)

II B.Tech II Semester:

1. Fundamentals of Electrical Circuits
2. Concepts of Electrical Measurements

III B.Tech I Semester:

1. Analysis of Linear Systems
2. Energy Auditing, Conservation and Management

III B.Tech II Semester:

1. Evolutionary Algorithms
2. Fundamentals of Power Electronics

IV B.Tech I Semester:

1. Neural Networks and Fuzzy Logic
2. Concepts of Electric Drives and Its Applications

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I Year I Semester		L	T	P	C
		3	0	0	3
COMMUNICATIVE ENGLISH					

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

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Unit 1:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications

Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Listening to short audio texts and identifying the topic. Listening to prose, prose and conversation.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.

Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.

Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit 2:

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications.(Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings. **Reading**: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

Grammar: Use of articles and zero article; prepositions.

Pronunciation: Past tense markers, word stress-di-syllabic words

Unit 3:

Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Pronunciation: word stress-poly-syllabic words.

Unit 4:

Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.**(Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.

Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.

Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Pronunciation: Contrastive Stress

Unit 5:

Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.

Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.

Reading for Writing: Writing academic proposals- writing research articles: format and style.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Pronunciation: Stress in compound words

Prescribed text books for theory for Semester-I:

1. "**Infotech English**", Maruthi Publications. (Detailed)

2."**The Individual Society",** Pearson Publications. (Non-detailed)

Prescribed text book for Laboratory for Semesters-I & II:

1. "**Infotech English**", Maruthi Publications. (With Compact Disc)

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Reference Books:

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.

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I Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-I (Calculus and Differential Equations)					

(Common to ALL branches of First Year B. Tech)

Course Objectives:

- To familiarize a variety of well-known sequences and series, with a developing intuition about the behavior of new ones.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- utilize mean value theorems to real life problems (L3)
- solve the differential equations related to various engineering fields (L3)
- familiarize with functions of several variables which is useful in optimization (L3)
- apply double integration techniques in evaluating areas bounded by region (L3)
- students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)

UNIT – I: Sequences, Series and Mean value theorems: (10hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series– Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders, Problems and applications on the above theorem.

UNIT – II: Differential equations of first order and first degree: (10hrs)

Linear differential equations– Bernoulli's equations –Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling– Law of natural growth and decay– Orthogonal trajectories– Electrical circuits.

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UNIT – III: Linear differential equations of higher order: (10hrs)

Homogeneous and Non-homogeneous differential equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, $e^{ax}V(x)$ and $x^nV(x)$ – Method of Variation of parameters, Cauchy and Legendre's linear equations.

Applications: LCR circuit, Simple Harmonic motion.

UNIT – IV: Partial differentiation: (10hrs)

Introduction – Homogeneous function – Euler's theorem– Total derivative– Chain rule– Jacobian – Functional dependence –Taylor's and MacLaurin's series expansion of functions of two variables.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method.

UNIT – V: Multiple integrals: (8 hrs)

Double and Triple integrals – Change of order of integration in double integrals – Change of variables to polar, cylindrical and spherical coordinates.
Applications: Finding Areas and Volumes.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2018
2. B. V. Ramana, Higher Engineering Mathematics, 6th Edition, Tata Mc. Graw Hill Education, 2007.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India, 2011.
2. Joel Hass, Christopher Heil and Maurice D. Weir, Thomas calculus, 14thEdition, Pearson, 2017.
3. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press, 2013.
4. Srimantha Pal, S. C. Bhunia, Engineering Mathematics, Oxford University Press, 2015.

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I Year I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-II (Linear Algebra and Numerical Methods) (Common to ALL branches of First Year B.Tech.)					

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate the approximate roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply numerical integral techniques to different Engineering problems (L3)
- apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations (L3)

UNIT – I: Solving systems of linear equations, Eigen values and Eigen vectors: (10hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous linear equations – Gauss Elimination method – Eigen values and Eigen vectors and properties (article-2.14 in text book-1).

Unit – II: Cayley–Hamilton theorem and Quadratic forms: (10hrs)

Cayley-Hamilton theorem (without proof) – Applications – Finding the inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation. Singular values of a matrix, singular value decomposition (text book-3).

UNIT – III: Iterative methods: (8 hrs)

Introduction– Bisection method–Secant method – Method of false position– Iteration method – Newton-Raphson method (One variable and simultaneous equations) – Jacobi and Gauss-Seidel methods for solving system of equations numerically.

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UNIT – IV: Interpolation: (10 hrs)
Introduction– Errors in polynomial interpolation – Finite differences– Forward differences– Backward differences –Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula– Newton's divide difference formula.

UNIT – V: Numerical differentiation and integration, Solution of ordinary differential equations with initial conditions: (10 hrs)
Numerical differentiation using interpolating polynomial – Trapezoidal rule– Simpson's $1/3^{rd}$ and $3/8^{th}$ rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method – Runge-Kutta method (second and fourth order).

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers, 2018
2. B. V. Ramana, Higher Engineering Mathematics, 6^{th} Edition, Tata McGraw Hill Education, 2007
3. David Poole, Linear Algebra- A modern introduction, 4^{th} Edition, Cengage, 2015

Reference Books:

1. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata McGraw Hill Education, 4^{th} Edition, 2018
2. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications, 3^{rd} Edition, 2020.
3. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press, 1^{st} Edition 2014.

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I Year I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C					

Course Objectives:

- To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
- To gain knowledge of the operators, selection, control statements and repetition in C
- To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
- To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
- To assimilate about File, I/O and significance of functions

UNIT I

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

UNIT II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multi-way Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

UNIT IV

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

Processor Commands: Processor Commands

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UNIT V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

Course Outcomes:

After the completion of the course the student should be able:

- To write algorithms and to draw flowcharts for solving problems
- To convert flowcharts/algorithms to C Programs, compile and debug programs
- To use different operators, data types and write programs that use two-way/ multi-way selection
- To select the best loop construct for a given problem
- To design and implement programs to analyze the different pointer applications
- To decompose a problem into functions and to develop modular reusable code
- To apply file I/O operations

Text Books:

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, 1st edition, Cengage, 2019.
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2 edition, Pearson, 2015.

References:

1. Computer Fundamentals and Programming, Sumithabha Das, 1st edition, McGraw Hill, 2018.
2. Programming in C, Ashok N. Kamthane, Amit Kamthane,3rd edition, Pearson, 2015.
3. Computer Fundamentals and Programming in C, PradipDey, ManasGhosh, 2nd edition, Oxford, 2013.

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I Year I Semester		L	T	P	C
		1	0	4	3
ENGINEERING DRAWING & DESIGN					

Course Objective: Engineering drawing being the principal method of communication for engineers,the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I
Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.
Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.
Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents and normal for the curves.
Scales: Plain scales, diagonal scales and vernier scales

Unit II
Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.
Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.
Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III
Objective: The objective is to make the students draw the projections of the plane inclined to both the planes.
Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV
Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.
Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit V
Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.
Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.
Computer Aided Design, drawing practice using Auto CAD, creating 2D&3D drawings of objects using Auto CAD

Note: In the End Examination there will be no question from CAD.

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TEXT BOOKS:

1. Engineering Drawing by N.D. Butt, 53rd edition, Charotar Publications, 2014.
2. Engineering Drawing by Agarwal & Agarwal,3rd edition, Tata McGraw Hill Publishers, 2019.

REFERENCE BOOKS:

1. Engineering Drawing by K. L. Narayana & P. Kannaiah, Scitech Publishers, 2011.
2. Engineering Graphics for Degree by K.C. John, 1st edition, PHI Publishers, 2009.
3. Engineering Graphics by PI Varghese, Mc Graw Hill Publishers, 2012.
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, 5th edition, New Age, 2011.

Course Outcome: The student will learn how to visualize 2D & 3D objects.

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I Year I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH COMMUNICATION SKILLS LABORATORY					

TOPICS

UNIT I:

Vowels, Consonants, Pronunciation, Phonetic Transcription, Common Errors in Pronunciation,

UNIT II:

Word stress-di-syllabic words, poly-syllabic words, weak and strong forms, contrastive stress (Homographs)

UNIT III:

Stress in compound words, rhythm, intonation, accent neutralisation.

UNIT IV:

Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions in speaking.

UNIT V:

Newspapers reading; Understanding and identifying key terms and structures useful for writing reports.

Prescribed text book: "**Infotech English**", Maruthi Publications.

References:

1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
6. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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I Year I Semester		L	T	P	C
		0	1	3	1.5
ELECTRICAL ENGINEERING WORKSHOP					

Course Objectives:

- To demonstrate the usage of measuring equipment
- To train the students in setting up simple wiring circuits
- To impart methods in electrical machine wiring

Any 10 of the following experiments are to be conducted

List of Experiments:

1. Study of various electrical tools and symbols.
2. Study various types of electrical cables/wires, switches, fuses, fuse carriers, MCB, ELCB, RCCB and MCCB with their specifications and usage.
3. Soldering and de-soldering practice.
4. Identification of various types of resistors and capacitors and understand the usage digital multi-meter.
5. Identification of various semiconductor devices.
6. Study of Moving Iron, Moving Coil, Electrodynamic and Induction type meters.
7. Fluorescent lamp wiring.
8. Wiring of lighting circuit using two-way control (stair case wiring)
9. Go down wiring/ Tunnel wiring
10. Hospital wiring.
11. Measurement of voltage, current, power in DC circuit.
12. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and energy meter for calculating Power and Power Factor.
13. Measurement of earth resistance.
14. Wiring of backup power supply for domestic Installations including inverter, battery and load.
15. Troubleshooting of domestic electrical equipment's (tube light and fan).
16. Understand the usage of CRO, function generator. & Regulated power supply and Measurement of ac signal parameters using CRO.
17. Assembling electronic components on bread board.
18. Obtain V-I characteristics of Light Emitting Diode.

Course Outcomes:

After the completion of the course the student should be able to:

- Explain the limitations, tolerances, safety aspects of electrical systems and wiring.
- Select wires/cables and other accessories used in different types of wiring.
- Make simple lighting and power circuits.
- Measure current, voltage and power in a circuit.

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I Year I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LAB (ES1202)					

Course Objectives:

- Apply the principles of C language in problem solving.
- To design flowcharts, algorithms and knowing how to debug programs.
- To design & develop of C programs using arrays, strings pointers & functions.
- To review the file operations, preprocessor commands.

Exercise 1:

- Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
- Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
- Write a C program to display multiple variables.

Exercise 2:

- Write a C program to calculate the distance between the two points.
- Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3:

- Write a C program to convert a string to a long integer.
- Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
- Write a C program to calculate the factorial of a given number.

Exercise 4:

- Write a program in C to display the n terms of even natural number and their sum.
- Write a program in C to display the n terms of harmonic series and their sum. 1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
- Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5:

- Write a program in C to print all unique elements in an array.
- Write a program in C to separate odd and even integers in separate arrays.
- Write a program in C to sort elements of array in ascending order.

Exercise 6:

- Write a program in C for multiplication of two square Matrices.
- Write a program in C to find transpose of a given matrix.

Exercise 7:

- Write a program in C to search an element in a row wise and column wise sorted matrix.
- Write a program in C to print individual characters of string in reverse order.

Exercise 8:

- Write a program in C to compare two strings without using string library functions.
- Write a program in C to copy one string to another string.

Exercise 9:

- Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
- Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10:

- Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
- Write a program in C to add two numbers using pointers.

Exercise 11:

- Write a program in C to add numbers using call by reference.
- Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12:

- Write a program in C to swap elements using call by reference.
- Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13:

- Write a program in C to show how a function returning pointer.
- Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14:

- Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand the difference between the above two programs
- Write a program in C to convert decimal number to binary number using the function.

Exercise 15:

- Write a program in C to check whether a number is a prime number or not using the function.
- Write a program in C to get the largest element of an array using the function.

Exercise 16:

- Write a program in C to append multiple lines at the end of a text file.
- Write a program in C to copy a file in another name.
- Write a program in C to remove a file from the disk.

Course Outcomes:

After the completion of the course the student should be able to:

- Gains Knowledge on various concepts of a C language.
- Draw flowcharts and write algorithms.
- Design and development of C problem solving skills.
- Design and develop modular programming skills.
- Trace and debug a program

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I Year II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-III (Vector Calculus, Transforms and PDE)					

Course Objectives:

- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real-world applications.

Course Outcomes: At the end of the course, the student will be able to

- interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- estimate the work done against a field, circulation and flux using vector calculus (L5)
- apply the Laplace transform for solving differential equations (L3)
- find or compute the Fourier series of periodic signals (L3)
- know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- identify solution methods for partial differential equations that model physical processes(L3)

UNIT –I: Vector calculus: (10 hrs)
Vector Differentiation: Gradient– Directional derivative – Divergence– Curl– Scalar Potential

Vector Integration: Line integral – Work done – Area– Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and problems on above theorems.

UNIT –II: Laplace Transforms: (10 hrs)
Laplace transforms – Definition and Laplace transforms of some certain functions– Shifting theorems – Transforms of derivatives and integrals – Unit step function –Dirac's delta function Periodic function – Inverse Laplace transforms– Convolution theorem (without proof).
Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT –III: Fourier series and Fourier Transforms: (10 hrs)
Fourier Series: Introduction– Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions –Change of interval– Half-range sine and cosine series.
Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties (article-22.5 in text book-1)– inverse transforms – Convolution theorem (without proof) – Finite Fourier transforms.

UNIT –IV: PDE of first order: **(8 hrs)**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

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UNIT – V: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients –non-homogeneous term of the type e^{ax+by}, $\sin(ax+by)$, $\cos(ax+by)$, $x^m y^n$.

Applications of PDE: Method of separation of Variables– Solution of One-dimensional Wave, Heat and two-dimensional Laplace equation.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2018.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata McGraw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India. 2015.
2. Dean. G. Duffy, Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press, 2010.
3. Peter O' Neil, Advanced Engineering Mathematics, 7th edition, Cengage, 2011..
4. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I Year II Semester		L	T	P	C
		3	0	0	3
APPLIED PHYSICS					

(For All Circuital Branches like ECE, EEE, CSE etc)

Unit-I: Wave Optics **12hrs**

Interference: Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colors in thin films- Newton's Rings- Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffraction - Fraunhofer diffraction due to single slit, double slit - N-slits (Qualitative) – Diffraction Grating - Dispersive power and resolving power of Grating(Qualitative).

Polarization: Introduction-Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates.

Unit Outcomes: The students will be able to

- **Explain** the need of coherent sources and the conditions for sustained interference (L2)
- **Identify** engineering applications of interference (L3)
- **Analyze** the differences between interference and diffraction with applications (L4)
- **Illustrate** the concept of polarization of light and its applications (L2)
- **Classify** ordinary polarized light and extraordinary polarized light (L2)

Unit-II: Lasers and Fiber optics **8hrs**

Lasers: Introduction – Characteristics of laser – Spontaneous and Stimulated emissions of radiation – Einstein's coefficients – Population inversion – Lasing action - Pumping mechanisms – Ruby laser – He-Ne laser - Applications of lasers.

Fiber optics: Introduction –Principle of optical fiber- Acceptance Angle - Numerical Aperture - Classification of optical fibers based on refractive index profile and modes – Propagation of electromagnetic wave through optical fibers - Applications.

Unit Outcomes: The students will be able to

- **Understand** the basic concepts of LASER light Sources (L2)
- **Apply** the concepts to learn the types of lasers (L3)
- **Identifies** the Engineering applications of lasers (L2)
- **Explain** the working principle of optical fibers (L2)
- **Classify** optical fibers based on refractive index profile and mode of propagation (L2)
- **Identify** the applications of optical fibers in various fields (L2)

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Unit III: Quantum Mechanics, Free Electron Theory and Band theory 10hrs

Quantum Mechanics: Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) – Quantum free electron theory– Equation for electrical conductivity based on quantum free electron theory- Fermi-Dirac distribution- Density of states (3D) - Fermi energy.

Band theory of Solids: Bloch's Theorem (Qualitative) - Kronig - Penney model (Qualitative)- E vs K diagram - V vs K diagram - effective mass of electron – Classification of crystalline solids–concept of hole.

Unit Outcomes:

The students will be able to

- **Explain** the concept of dual nature of matter (L2)
- **Understand** the significance of wave function (L2)
- **Interpret** the concepts of classical and quantum free electron theories (L2)
- **Explain** the importance of K-P model
- **Classify** the materials based on band theory (L2)
- **Apply** the concept of effective mass of electron (L3)

Unit-IV: Dielectric and Magnetic Materials 8hrs

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility and Dielectric constant - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field- Clausius- Mossotti equation- Piezoelectricity.

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability - Origin of permanent magnetic moment - Classification of magnetic materials: Dia, para, Ferro, antiferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials- Eddy currents- Engineering applications.

Unit Outcomes: The students will be able to

- **Explain** the concept of dielectric constant and polarization in dielectric materials (L2)
- **Summarize** various types of polarization of dielectrics (L2)
- **Interpret** Lorentz field and Claussius-Mosotti relation in dielectrics(L2)
- **Classify** the magnetic materials based on susceptibility and their temperature dependence (L2)
- **Explain** the applications of dielectric and magnetic materials (L2)
- **Apply** the concept of magnetism to magnetic data storage devices (L3)

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Unit – V: Semiconductors and Superconductors 10hrs

Semiconductors: Introduction- Intrinsic semiconductors – Density of charge carriers – Electrical conductivity – Fermi level – extrinsic semiconductors – density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein's equation- Hall effect – Hall coefficient –Applications of Hall effect.

Superconductors: Introduction – Properties of superconductors – Meissner effect – Type I and Type II superconductors – BCS theory (Qualitative) – Josephson effects (AC and DC) – SQUIDs High T_c superconductors – Applications of superconductors.

Unit Outcomes: The students will be able to

- **Classify** the energy bands of semiconductors (L2)
- **Interpret** the direct and indirect band gap semiconductors (L2)
- **Identify** the type of semiconductor using Hall effect (L2)
- **Identify** applications of semiconductors in electronic devices (L2)
- **Classify** superconductors based on Meissner's effect (L2)
- **Explain** Meissner's effect, BCS theory & Josephson effect in superconductors (L2)

Text books:

1. M. N. Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy" A Text book of Engineering Physics"- S.Chand Publications, 11th Edition 2019.
2. Engineering Physics" by D.K.Bhattacharya and Poonam Tandon, 1st edition, Oxford press, 2015.
3. Applied Physics by P.K.Palanisamy 3rd edition, SciTech publications, 2013.

Reference Books:

1. Fundamentals of Physics – Halliday, Resnick and Walker,10th edition, John Wiley &Sons, 2013.
2. Engineering Physics by M.R.Srinivasan, New Age international publishers, 2009.
3. Shatendra Sharma, Jyotsna Sharma, " Engineering Physics", 1st edition, Pearson Education, 2018.
4. Engineering Physics - Sanjay D. Jain, D. Sahasrabudhe and Girish, 1st edition, University Press, 2010.
5. Semiconductor physics and devices- Basic principle – Donald A, Neamen, 3rd edition, Mc Graw Hill, 2003.
6. B.K. Pandey and S. Chaturvedi, Engineering Physics, 1st edition, Cengage Learning, 2013.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I Year II Semester		L	T	P	C
		3	0	0	3
DATA STRUCTURES THROUGH C					

Preamble:
This course is core subject developed to help the student understand the data structure principles used in power systems, machines and control systems. This subject covers linear data structures, linked lists, trees, graphs, searching and sorting.

Course Objectives:

- Operations on linear data structures and their applications.
- The various operations on linked lists.
- The basic concepts of Trees, Traversal methods and operations.
- Concepts of implementing graphs and its relevant algorithms.
- Sorting and searching algorithms.

Unit-1: Linear Data Structures: Arrays, Stacks and Queues
Data Structures -Operations-Abstract Data Types-Complexity of Algorithms-Time and Space-Arrays-Representation of Arrays-Linear Arrays-Insertion–Deletion and Traversal of a Linear Array-Array as an Abstract Data Type-Multi-Dimensional Arrays-Strings-String Operations-Storing Strings-String as an Abstract Data Type

Stack -Array Representation of Stack-Stack Abstract Data Type-Applications of Stacks: Prefix-Infix and Postfix Arithmetic Expressions-Conversion-Evaluation of Postfix Expressions-Recursion-Towers of Hanoi-Queues-Definition-Array Representation of Queue-The Queue Abstract Data Type-Circular Queues-Dequeues-Priority Queues.

Unit-II: Linked Lists
Pointers-Pointer Arrays-Linked Lists-Node Representation-Single Linked List-Traversing and Searching a Single Linked List-Insertion into and Deletion from a Single Linked List-Header Linked Lists-Circularly Linked Lists-Doubly Linked Lists-Linked Stacks and Queues-Polynomials-Polynomial Representation-Sparse Matrices.

Unit-III: Trees
Terminology-Representation of Trees-Binary Trees-Properties of Binary Trees-Binary Tree Representations-Binary Tree Traversal-Preorder-In-order and Post-order Traversal-Threads-Thread Binary Trees-Balanced Binary Trees-Heaps-Max Heap-Insertion into and Deletion from a Max Heap-Binary Search Trees-Searching-Insertion and Deletion from a Binary Search Tree-Height of Binary Search Tree, m-way Search Trees, B-Trees.

Unit-IV: Graphs

Graph Theory Terminology-Graph Representation-Graph Operations-Depth First Search-Breadth First Search-Connected Components-Spanning Trees-Biconnected Components-Minimum Cost Spanning Trees-Kruskal's Algorithm-Prism's Algorithm-Shortest Paths-Transitive Closure-All-Pairs Shortest Path-Warshall's Algorithm.

Unit-V: Searching and Sorting

Searching -Linear Search-Binary Search-Fibonacci Search-Hashing-Sorting-Definition-Bubble Sort-Insertion sort-Selection Sort-Quick Sort-Merging-Merge Sort-Iterative and Recursive Merge Sort-Shell Sort-Radix Sort-Heap Sort.

Course Outcomes:

After the completion of the course the student should be able to:

- data structures concepts with arrays, stacks, queues.
- linked lists for stacks, queues and for other applications.
- traversal methods in the Trees.
- various algorithms available for the graphs.
- sorting and searching in the data ret retrieval applications.

Text Books:

1. Fundamentals of Data Structures in C, 2nd Edition, E.Horowitz, S.Sahni and Susan Anderson Freed, Universities Press Pvt. Ltd.
2. Data Structures with C, Seymour Lipschutz, Schaum's Outlines, Tata McGraw Hill.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I Year II Semester		L	T	P	C
		3	0	0	3
ELECTRICAL CIRCUIT ANALYSIS -I					

Preamble:
This course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the basic analysis of circuits which includes single phase circuits, magnetic circuits, network theorems, transient analysis and network topology.

Course Objectives:
- To study the concepts of passive elements, types of sources and various network reduction techniques.
- To understand the applications of network topology to electrical circuits.
- To study the concept of magnetic coupled circuit.
- To understand the behavior of RLC networks for sinusoidal excitations.
- To study the performance of R-L, R-C and R-L-C circuits with variation of one of the parameters and to understand the concept of resonance.
- To understand the applications of network theorems for analysis of electrical networks.

UNIT-I
Introduction to Electrical Circuits
Basic Concepts of passive elements of R, L, C and their V-I relations, Sources (dependent and independent), Kirchhoff's laws, Network reduction techniques (series, parallel, series - parallel, star-to-delta and delta-to-star transformation), source transformation technique, nodal analysis and mesh analysis to DC networks with dependent and independent voltage and current sources., node and mesh analysis.

UNIT-II
Magnetic Circuits
Basic definition of MMF, flux and reluctance, analogy between electrical and magnetic circuits, Faraday's laws of electromagnetic induction – concept of self and mutual inductance, Dot convention – coefficient of coupling and composite magnetic circuit, analysis of series and parallel magnetic circuits.

UNIT-III
Single Phase A.C Systems
Periodic waveforms (determination of rms, average value and form factor), concept of phasor, phase angle and phase difference – waveforms and phasor diagrams for lagging, leading networks, complex and polar forms of representations. node and mesh analysis.
Steady state analysis of R, L and C circuits, power factor and its significance, real, reactive and apparent power, waveform of instantaneous power and complex power.

UNIT-IV
Resonance - Locus Diagrams
series and parallel resonance, selectively band width and Quality factor, locus diagram- RL, RC, RLC with R, L and C variables.

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UNIT-V

Network theorems (DC & AC Excitations)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

Course Outcomes:

After the completion of the course the student should be able to:

- Various electrical networks in presence of active and passive elements.
- Electrical networks with network topology concepts.
- Any magnetic circuit with various dot conventions.
- Any R, L, C network with sinusoidal excitation.
- Any R, L, network with variation of any one of the parameters i.e., R, L, C and f.
- Electrical networks by using principles of network theorems.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E. Kemmerley, 6th edition McGraw Hill Company, 2012.
2. Network Analysis: Van Valkenburg; Prentice-3rd edition, Hall of India Private Ltd, 2015.

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K. Alexander and Mathew N.O.Sadiku, 5th edition, McGraw Hill Education (India), 2013.
2. Linear Circuit Analysis by De Carlo, Lin, 2nd edition, Oxford publications, 2001.
3. Electric Circuits – (Schaum's outlines) by Mahmood Nahvi & Joseph Edminister, Adapted by KumaRao, 5th Edition – McGraw Hill, 2017.
4. Electric Circuits by David A. Bell, 7th edition, Oxford publications, 2009.
5. Introductory Circuit Analysis by Robert L Boylestad, 13th edition, Pearson, 2015
6. Circuit Theory (Analysis and Synthesis) by A. Chakrabarthi, 7th edition, DhanpatRai&Co., 2018.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I Year II Semester		L	T	P	C
		3	0	0	3
BASIC CIVIL AND MECHANICAL ENGINEERING					

Course Objectives:

COB 1: To impart basic principles of stress, strain, shear force and bending moment.
COB 2: To teach principles of strain measurement using electrical strain gauges.
COB 3: To impart basic characteristics of building materials.
COB 4: To familiarize the sources of energy, power plant economics and environmental aspects.
COB 5: To make the students to understand the basics concept of Boilers & I.C. engines.

Course Outcomes:

At the end of this course, the student will be able to

CO 1 : Apply Shear force diagram & Bending moment diagram principles for Cantilever and Simply supported beams.
CO 2 : Apply concepts of Rosette analysis for strain measurements.
CO 3 : Analyse the characteristics of common building materials.
CO 4 : Compare the working characteristics of Internal Combustion engines.
CO 5 : Compare the differences between boiler mountings and accessories.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1 (K3)	PO 2 (K4)	PO 3 (K5)	PO 4 (K3)	PO 5 (K3)	PO 6 (K3)	PO 7 (K2)	PO 8 (K3)	PO 9 (K2)	PO 10 (K2)	PO 11 (K3)	PO12 (K)
CO1 (K3)	3	2	-	-	-	-	2	-	-	-	-	-
CO2 (K3)	3	2	-	-	-	-	3	-	-	-	-	-
CO3 (K4)	3	3	-	-	-	-	3	-	-	-	-	-
CO4 (K4)	2	3	-	-	-	-	3	-	-	-	-	-
CO5 (K4)	3	3	-	-	-	-	3	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes

CO / PSO	PSO 1(K5)	PSO 2(K5)	PSO 3(K3)
CO1 (K3)	-	-	-
CO2 (K3)	-	1	-
CO3 (K4)	-	2	-
CO4 (K4)	-	-	-
CO5 (K4)	-	2	-

UNIT – I:

Basic Definitions of Force –Stress –Strain –Elasticity. Shear force – Bending Moment Torsion . Simple problems on Shear force Diagram and Bending moment Diagram for cantilever and simply supported beams.

UNIT – II:

Measurement of Strain - Electrical Capacitance and Resistance Strain gauges multi channel strain indicators. Rosette analysis Rectangular and Triangular strain rosettes.

UNIT – III:

Characteristics of common building materials – Brick – Types Testing; Timber Classification Seasoning Defects in Timber; Glass Classification uses; steel and its applications in construction industry.

UNIT IV

Hydraulic Turbines and Pumps:

Introduction to Power transmission tools, Hydraulic Turbines: Classification-Difference between Impulse and Reaction Turbine.
Pumps: Classification of Pumps, Centrifugal Pump-Applications-Priming-Reciprocating Pumps, Single Acting & Double acting-Comparison with Centrifugal Pump

UNIT V –

I.C Engine: Heat Engine – Types of Heat Engine–Classification of I.C. Engine-Valve Timing Diagram, Port Timing Diagram- Comparison of 2S & 4S Engines- Comparisonof Petrol Engine and Diesel Engine-Fuel System of a Petrol Engine-Ignition Systems.
Boilers: Classification of Boilers – – Simple Vertical Boiler – Cochran Boiler – Babcock and Wilcox Boiler Benson Boiler Difference between Fire Tube and Water Tube Boilers Boiler Mountings and Accessories.

Text Books:

1. Basic Civil and Mechanical Engineering, by Prof. V. Vijayan, Prof. M. Prabhakaran and Er. R. Viashnavi, 2nd edition, S. Chand Publication, 2010
2. Elements of Mechanical Engineering, Fourth Edition, S. Trymbaka Murthy, University Press, 2014
4. Shanmugam G and Palanichamy M S, Basic Civil and Mechanical Engineering, Tata McGraw Hill Publishing Co., New Delhi, (1996).
5. Ramamrutham S., Basic Civil Engineering, Dhanpat Rai Publishing Co. (P) Ltd. (1999).

Reference Books:

1. Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, (2005).
2. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, (2000).
3. Er. R. Vaishnavi, Basic Civil and Mechanical Engineering, 2/e, S.Chand Publications (2003)

Web Links:

1. http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHsbmIntro.pdf
2. http://www.hillagric.ac.in/edu/coa/agengg/lecture/243/Lecture%203%20Engine.pdf

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I Year II Semester		L	T	P	C
		0	0	3	1.5
APPLIED PHYSICS LAB					

(For All Circuital Branches like CSE, ECE, EEE etc.)

(Any 10 of the following listed experiments)

List of Applied Physics Experiments

1. Determination of thickness of thin object by wedge method.
2. Determination of radius of curvature of a given plano convex lens by Newton's rings.
3. Determination of wavelengths of different spectral lines in mercury spectrumusing diffraction grating in normal incidence configuration.
4. Determination of dispersive power of the prism.
5. Determination of dielectric constant using charging and discharging method.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Determination of numerical aperture and acceptance angle of an optical fiber.
8. Determination of wavelength of Laser light using diffraction grating.
9. Estimation of Planck's constant using photoelectric effect.
10. Determination of the resistivity of semiconductor by four probe method.
11. To determine the energy gap of a semiconductor using p-n junction diode.
12. Magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method
13. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall Effect .
14. Measurement of resistance of a semiconductor with varying temperature.
15. Resistivity of a Superconductor using four probe method & Meissner effect.

References:

1. S. Balasubramanian, M.N. Srinivasan "A Text Book of PracticalPhysics"- S Chand Publishers, 2017.

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I Year II Semester		L	T	P	C
		0	0	3	1.5
BASIC CIVIL AND MECHANICAL ENGINEERING LAB					

Preamble:

Course Objectives:

COB 1: To make the student learn about the constructional features and operational details of various types of internal combustion engines.
COB 2: To make the student learn about the constructional features, operational details of various types of hydraulic turbines
COB 3: To practice the student about the fundamental of fluid dynamic equations and its applications fluid jets.
COB 4: To train the student in the areas of types of hydro electric power plants, estimation and calculation of different loads by considering various factors.

Course Outcomes:

At the end of the Course, Student will be able to:

CO 1: Solve to arrive at finding constant speed and variable speed on IC engines and interpret their performance.
CO 2: Estimate energy distribution by conducting heat balance test on IC engines
CO 3: Explain procedure for standardization of experiments.
CO 4: Determine flow discharge measuring device used in pipes channels and tanks.
CO 5: Determine fluid and flow properties.
CO 6: Solve for drag coefficients.
CO 7: Test for the performance of pumps and turbines

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO 1 (K3)	PO 2 (K4)	PO 3 (K5)	PO 4 (K5)	PO 5 (K3)	PO 6 (K3)	PO 7 (K2)	PO 8 (K3)	PO 9 (K2)	PO 10 (K2)	PO 11 (K3)	PO 12 (K3)
CO1(K3)	3	2	1	1	3	3	-	-	-	2	3	-
CO2(K5)	3	3	-	-	3	3	-	-	-	3	3	-
CO3(K2)	2	1	-	-	2	2	-	-	-	3	2	-
CO4(K5)	3	3	3	3	3	3	-	-	-	-	3	-
CO5(K5)	3	3	3	3	3	3	-	-	-	-	3	-
CO6(K3)	3	2	1	1	3	3	-	-	-	3	3	-
CO7(K4)	3	3	2	2	3	3	-	-	-	3	3	-

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Mapping of Course Outcomes with Program Specific Outcomes

CO/PSO	PSO 1 (K5)	PSO 2 (K5)	PSO 3 (K3)
CO1 (K3)	-	-	-
CO2 (K5)	-	-	-
CO3 (K2)	-	-	-
CO4 (K5)	-	-	-
CO5 (K5)	-	-	-
CO6 (K3)	-	-	-
CO7 (K4)	-	3	-

Part-A

List of Experiments:

Thermal Engineering Lab:

1. Valve time timing diagram on 4-S Diesel engine.
2. Valve time timing diagram on 4-S Petrol engine.
3. Port timing diagram on 2-S Petrol engine.
4. Study on Boiler models.
5. COP determination of Refrigeration tutor.
6. COP determination of Air conditioner tutor.

Part-B

Hydraulic machinery Lab:

1. Determination of coefficient of discharge on Impact of Jets on Vanes apparatus.
2. Performance test on Pelton wheel.
3. Performance test on Francis turbine.
4. Performance test on Kaplan turbine.
5. Performance test on Single stage Centrifugal pump.
6. Performance test on Reciprocating pump.

List of Augmented Experiments:

(Student can perform any one of the following experiments)

1. Heat balance sheet on VCR engine
2. Determination of Loss of head due to sudden contraction and suddenenlargement.
3. Heat balance sheet on Multi cylinder Petrol engine.
4. Heat balance sheet on 4-S diesel engine.
5. Determination of coefficient of discharge on Venturimeter.
6. Determination of coefficient of discharge on Orificemeter.

Web Links:

1. https://www.iare.ac.in/sites/default/files/lab2/TE%2Blab.pdf
2. https://www.dbit.ac.in/ce/syllabus/hydraulics-and-hydraulic-machines-lab.pdf

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I Year II Semester		L	T	P	C
		0	0	3	1.5
DATA STRUCTURES THROUGH C LAB					

Any 10 of the following experiments are to be conducted

Course Objectives:

- To develop skills to design and analyze simple linear and non linear data structures.
- To strengthen the ability to the students to identify and apply the suitable data structure for the given real world problem.
- To gain knowledge in practical applications of data structures.

List of Experiments:

1. Implement operations on Strings.
2. Implement basic operations on Stacks.
3. Implement basic operations on Queue.
4. Implement basic operations on Circular Queue.
5. Implement multi stack in a single array.
6. Implement List data structure using i) array ii) singly linked list.
7. Implement basic operations on doubly linked list.
8. Implement basic operations (insertion, deletion, search, find min and find max) on Binary Search trees.
9. Implementation of Heaps.
10. Implementation of Breadth First Search Techniques.
11. Implementation of Depth First Search Techniques.
12. Implementation of Prim's algorithm.
13. Implementation of Kruskal's Algorithm.
14. Implementation of Linear search.
15. Implementation of Fibanocci search.
16. Implementation of Merge sort.
17. Implementation of Quick sort**.**

Course Outcomes:

After the completion of the course the student should be able to:

- Be able to design and analyze the time and space efficiency of the data structure.
- Be capable to identity the appropriate data structure for given problem.
- Have practical knowledge on the applications of data structures.

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I Year II Semester		L	T	P	C
		2	0	0	0
CONSTITUTION OF INDIA					

Preamble:

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

Learning outcomes: -After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions

Learning outcomes: -After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariat

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UNIT-IV

A. Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation Pachayati Raj: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes: -After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zilla panchayat block level organization

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission, Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes: -After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

References:

1. Durga Das Basu, Introduction to the Constitution of India, 12th edition Prentice – Hall of India Pvt. Ltd. New Delhi 2011.
2. Subash Kashyap, Indian Constitution, 2nd edition, National Book Trust, 2011.
3. J.A. Siwach, Dynamics of Indian Government & Politics, 2nd edition, Sterling Pub Private Ltd.,1990.
4. D.C. Gupta, Indian Government and Politics, 8th edition, Vikas Publishing House Pvt Ltd., 2015.
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication), 2015.
6. J.C. Johari, Indian Government and Politics Hans, 13th edition, Shoban Lal & Co.2012.
7. J. Raj Indian Government and Politics, 1st edition, SAGE Texts Publication, 2008.
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, 3rd edition, Lexis Nexis Publications, 2008.
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

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Course Outcomes:
At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government i.e., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
  1. Know the sources, features and principles of Indian Constitution.
  2. Learn about Union Government, State government and its administration.
  3. Get acquainted with Local administration and Pachayati Raj.
  4. Be aware of basic concepts and developments of Human Rights.
  5. Gain knowledge on roles and functioning of Election Commission

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II Year I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-IV (Complex Variables and Statistical Methods)					

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

UNIT – I: Functions of a complex variable and Complex integration: (10 hrs)

Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.
Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II: Series expansions and Residue Theorem: (10 hrs)

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated – Essential –Pole of order m– Residues – Residue theorem (without proof) – Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x)dx$ and

UNIT – III: Probability and Distributions: (10 hrs)

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: (8 hrs)

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V: Tests of Hypothesis: (10 hrs)

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

Course Outcomes: At the end of the course students will be able to

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- find the differentiation and integration of complex functions used in engineering problems (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)
- apply discrete and continuous probability distributions (L3)
- design the components of a classical hypothesis test (L6)
- infer the statistical inferential methods based on small and large sampling tests (L4)

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.
2. **Miller and Freund's,** Probability and Statistics for Engineers,Pearson,7th edition, 2008.

Reference Books:

1. **J. W. Brown and R. V. Churchill**, Complex Variables and Applications, 9th edition, Mc-Graw Hill, 2013.
2. **S.C. Gupta and V.K. Kapoor**, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons Publications, 2012.
3. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. **Shron L.Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
5. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4thEdition, Academic Foundation,2011

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II Year I Semester		L	T	P	C
		3	0	0	3
ELECTRONIC DEVICES AND CIRCUITS					

Preamble:
This course introduces the concepts of semi-conductor physics and operation of various semi-conductor devices. Realization of rectifiers, amplifiers and oscillators using semi-conductor devices, transistors and their analysis is introduced in this course.

Course Objectives:
The main objectives of this course are:

- The basic concepts of semiconductor physics are to be reviewed.
- Study the physical phenomena such as conduction, transport mechanism and electrical characteristics of different diodes.
- The application of diodes as rectifiers with their operation and characteristics with and without filters are discussed.
- The principal of working and operation of Bipolar Junction Transistor and Field Effect Transistor and their characteristics are explained.
- The need of transistor biasing and its significance is explained. The quiescent point or operating point is explained.
- Small signal equivalent circuit analysis of BJT and FET transistor amplifiers in different configuration is explained.

UNIT - I

Semi-Conductor Physics: Insulators, Semiconductors, and Metals, classification using energy band diagrams, mobility and conductivity, electrons and holes in intrinsic semiconductors, extrinsic semiconductors, drift and diffusion, charge densities in semiconductors, Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors

Junction Diode Characteristics: Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance, energy band diagram of PN junction Diode.

UNIT - II

Special Semiconductor Devices: Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Photodiode, Tunnel Diode, SCR, UJT. Construction, operation and characteristics of all the diodes are required to be considered.

Rectifiers and Filters: Basic Rectifier setup**,** half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter, Capacitor filter, comparison of various filter circuits in terms of ripple factors.

UNIT - III

BJT: Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/ reach through, Photo transistor, typical transistor junction voltage values.

FET: FET types, construction, operation, characteristics, parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

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UNIT - IV

Transistor Biasing and Thermal Stabilization: Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self-bias, Stabilization against variations in V_{BE}, I_c, and β, Stability factors, (S, S', S''), Bias compensation, Thermal runaway, Thermal stability. FET Biasing- methods and stabilization.

UNIT –V

Small Signal Low Frequency Transistor Amplifier Models:

BJT: Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.

FET: Generalized analysis of small signal model, Analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

Course Outcomes:

At the end of this course the student can able to:

- Understand the basic concepts of semiconductor physics.
- Understand the formation of p-n junction and how it can be used as a p-n junction as diode in different modes of operation.
- Know the construction, working principle of rectifiers with and without filters with relevant expressions and necessary comparisons.
- Understand the construction, principle of operation of transistors, BJT and FET with their V-I characteristics in different configurations.
- Know the need of transistor biasing, various biasing techniques for BJT and FET and stabilization concepts with necessary expressions.
- Perform the analysis of small signal low frequency transistor amplifier circuits using BJT and FET in different configurations.

Text Books:

1. Electronic Devices and Circuits- J. Millman, C.Halkias, Tata Mc-Graw Hill, 2nd Edition,2010.
2. Electronics devices & circuit theory- Robert L.Boylestad and LouiNashelsky, Pearson/Prentice hall, 10th edition, 1999.

References:

1. Electronic Devices and Circuits-K. Satya Prasad, VGS Book Links, 2nd Edition, 2006.
2. Electronic Devices and Circuits-Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, 2nd Edition, 2018.
3. Electronic Devices and Circuits – David Bell, Oxford, 5th Edition, 2008.

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II Year I Semester		L	T	P	C
		3	0	0	3
ELECTRICAL CIRCUIT ANALYSIS - II					

Preamble:
This course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the basic analysis of circuits which includes single phase circuits, magnetic circuits, network theorems, transient analysis and network topology.

Course Objectives:

- To study the concepts of passive elements, types of sources and various network reduction techniques.
- To understand the applications of network topology to electrical circuits.
- To study the concept of magnetic coupled circuit.
- To understand the behavior of RLC networks for sinusoidal excitations.
- To study the performance of R-L, R-C and R-L-C circuits with variation of one of the parameters and to understand the concept of resonance.
- To understand the applications of network theorems for analysis of electrical networks.

UNIT - I
Balanced and Unbalanced Three phase circuits
Analysis of three phase balanced circuits:
Phase sequence, star and delta connection of sources and loads, relation between line and phase voltages and currents, analysis of balanced three phase circuits, measurement of active and reactive power.
Analysis of three phase unbalanced circuits:
Loop method, Star-Delta transformation technique, two-wattmeter method for measurement of three phase power.

UNIT - II
Transient Analysis in DC Circuits
Transient response of First order (R-L, R-C) and second order (R-L-C) circuits using differential equations.
Transient response of First order (R-L, R-C) and second order (R-L-C) circuits using Laplace transforms.

UNIT - III
Transient Analysis in AC circuits
Transient response of First order (R-L, R-C) and second order (R-L-C) circuits using differential equations.

Transient response of First order (R-L, R-C) and second order (R-L-C) circuits using Laplace transforms.

UNIT - IV
Two Port Networks
Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, cascaded networks.

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UNIT - V

Filters

Need of Filters – Classification -Characteristic impedance- Low Pass Filter, High Pass Filter, Band Pass Filter, Band Stop or Band Elimination Filter, m-Derived Filter, Composite filters– Design of Filters.

Course Outcomes:

At the end of the course, student will be able to

- Understand the concepts of balanced and unbalanced three-phase circuits.
- Know the transient behavior of electrical networks with DC excitations.
- Learn the transient behavior of electrical networks with AC excitations.
- Estimate various parameters of a two port network.
- Understand the significance of filters in electrical networks.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley, McGraw Hill Company,9thedition, 2018.
2. Network analysis: Van Valkenburg: Prentice-Hall of India Private Ltd, 3rd edition, 2019.

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India), 6th edition, 2019.
2. Introduction to circuit analysis and design by Tildon H Glisson. Jr, Springer Publications, 1st edition, 2011.
3. Circuits by A.Bruce Carlson, Cengage Learning Publications, 1st edition, 2008.
4. Network Theory Analysis and Synthesis by SmarajitGhosh, PHI publications, ninth print, 2015.
5. Networks and Systems by D. Roy Choudhury, New Age International publishers, 2nd edition, 2013.
6. Electric circuit by Joseph Edminister, Schaum's outlines series, seventh edition, 2017.
7. Electric Circuits by David A. Bell, Oxford publications, 7th edition, 2009.
8. Circuit Theory (Analysis and Synthesis) by A.Chakrabarthi, DhanpatRai&Co, 7th-Revised edition, 2018)

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II Year I Semester		L		T	P	C
		3		0	0	3
DC MACHINES AND TRANSFORMERS						

Preamble:
This is a basic course on rotating electrical machines. This course covers the topics related to principles, performance, applications and design considerations of dc machines and transformers.

Course Objectives:

- To Understand the construction, principle of operation and performance of DC machines.
- To Learn the characteristics, performance, methods of speed control and testing methods of DC motors.
- To predetermine the performance of single phase transformers with equivalent circuit models.
- To Understand the methods of testing of single-phase transformer.
- To Analyze the three phase transformers and achieve three phase to two phase conversion.

UNIT - I
Electromechanical Energy Conversion and introduction to DC machines
Principles of electromechanical energy conversion - singly excited and multi excited systems-calculation of force and torque using the concept of co-energy**.**
Construction and principle of operation of DC machines – EMF equation for generator – Excitation techniques– characteristics of DC shunt generator –applications of DC Generators

UNIT - II
Operation of DC motors
Back-emf and torque equations of dc motors – Armature reaction and commutation – characteristics of separately-excited, shunt, series and compound motors – losses and efficiency – applications of dc motors.
Necessity of a starter – starting by 3 point and 4-point starters.

UNIT - III
Speed Control of motors and Testing of DC Machines
Speed control by armature voltage and field control – testing of DC machines – brake test, Swinburne's method – principle of regenerative or Hopkinson's method – retardation test – field's test- separation of losses.

Single-phase Transformers
Types and constructional details – principle of operation –emf equation – operation on no load and on load – lagging, leading and unity power factors loads –phasor diagrams of transformers – equivalent circuit.

UNIT - IV
Performance and testing of transformers and auto transformers:
Regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – all day efficiency.
Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses – parallel operation with equal voltage ratios – auto transformer – equivalent circuit – comparison with two winding transformers.

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UNIT - V

3-Phase Transformer:

Polyphase connections- Y/Y, Y/ Δ, Δ/Y, Δ/ Δ and open Δ- third harmonics in phase voltages – three winding transformers- transients in switching –off load and on load tap changers- Scott connection.

Course Outcomes:

At the end of the course, student will be able to:

- Assimilate the concepts of electromechanical energy conversion.
- Mitigate the ill-effects of armature reaction and improve commutation in dc machines.
- Understand the torque production mechanism and control the speed of dc motors.
- Analyze the performance of single phase transformers.
- Predetermine regulation, losses and efficiency of single phase transformers.
- Parallel transformers, control voltages with tap changing methods and achieve three-phase to two-phase transformation.

Text Books:

1. Electrical Machines by P.S. Bhimbra, Khanna Publishers,7th edition, 2011.
2. Electric Machinery by A.E.Fitzgerald, Charleskingsley, Stephen D.Umans, TMH, 6th edition, 2003.

Reference Books:

1. Electrical Machines by D. P.Kothari, I. J. Nagarth, McGraw Hill Publications, 4th edition, 2010.
2. Electrical Machines by R.K.Rajput, Lakshmi publications, 5th edition.
3. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, McGraw Hill, 1st edition.
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education, 4th edition, 2010.
5. Electric Machines by MulukutlaS.Sarma & Mukeshk Pathak, CENGAGE Learning, 1st edition, 2008.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons, 1st edition, 2009.

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II Year I Semester		L	T	P	C
		3	0	0	3
ELECTRO MAGNETIC FIELDS					

Preamble:
Electromagnetic field theory is the pre-requisite for most of the subjects in the gamut of electrical engineering. The study of this subject enables students to understand and interpret the phenomenon pertinent to electrical engineering using microscopic quantities such as electric and magnetic field intensities, scalar and vector potentials.

Course Objectives:

- To study the production of electric field and potentials due to different configurations of static charges.
- To study the properties of conductors and dielectrics, calculate the capacitance of different configurations. Understand the concept of conduction and convection current densities.
- To study the magnetic fields produced by currents in different configurations, application of Ampere's law and the Maxwell's second and third equations.
- To study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other current loops.
- To develop the concept of self and mutual inductances and the energy stored.
- To study time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the induced EMF

UNIT - I

Electrostatics:

Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge, work done in moving a point charge in an electrostatic field, electric potential – potential gradient, Gauss's law – Maxwell's first law (div(D)=ρ_v), Laplace's and Poison's equations and solution of Laplace's equation in one variable.

UNIT - II

Conductors – Dielectrics and Capacitance:

Electric dipole – dipole moment – potential and EFI due to an electric dipole, Torque on an Electric dipole in an electric field, conductors and Insulators – their behavior in electric field. Polarization, boundary conditions between conductor to dielectric, dielectric to dielectric and conductor to free space. Capacitance of parallel plates, spherical dielectrics, energy stored and energy density in a static electric field, current density, conduction and convection current densities, Ohm's law in point form – equation of continuity.

UNIT - III

Magneto statics, Ampere's Law and Force in magnetic fields:

Biot-Savart's law and its applications viz. Straight current carrying filament, circular, square, rectangle and solenoid current carrying wire – Maxwell's second Equation (div(B)=0), Ampere's circuital law and its applications viz. MFI due to an infinite sheet, long filament, solenoid, toroidal current carrying conductor, point form of Ampere's circuital law, Maxwell's third equation (Curl (H)=J)

Magnetic force, moving charges in a magnetic field – Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors.

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UNIT - IV

Self and mutual inductance:

Self and mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT - V

Time Varying Fields:

Faraday's laws of electromagnetic induction – integral and point forms, Maxwell's fourth equation (Curl(E)=-∂B/∂t), statically and dynamically induced EMF – modification of Maxwell's equations for time varying fields, displacement current, Poynting theorem and Poynting vector.

Course Outcomes:

At the end of the course, student will be able to,

- Compute electric fields and potentials using Gauss law or solve Laplace's or Poisson's equations for various electric charge distributions.
- Calculate the capacitance and energy stored in dielectrics.
- Calculate the magnetic field intensity due to current carrying conductor and understanding the application of Ampere's law, Maxwell's second and third law.
- Estimate self and mutual inductances and the energy stored in the magnetic field.
- Understand the concepts of displacement current and Poynting theorem and Poynting vector

Text Books:

1. "Engineering Electromagnetics" by William H. Hayt & John. A. Buck Mc. Graw-Hill, 7th Editon.2006.
2. "Principles of Electro Magnetics" by Sadiku, Oxford Publications, 6th edition, 2015.

Reference Books:

1. Introduction to Electro Dynamics by D J Griffiths, Prentice-Hall of India Pvt. Ltd, 2nd edition
2. Electromagnetic Field Theory by Yaduvir Singh, Pearson India, 1st edition, 2011.
3. Fundamentals of Engineering Electro magnetics by Sunil Bhooshan, Oxford UniversityPress, 2012.
4. Electro magnetics by Joseph A. Edminister, Schaum's Outline,4th Edition,2014.

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II Year I Semester		L	T	P	C
		0	0	3	1.5
ELECTRICAL CIRCUITS LAB					

Preamble:
To verify and demonstrate various theorems, locus diagrams, resonance and two port networks. To determine self and mutual inductance of a magnetic circuit, parameters of a given coil and measurement of 3- phase power.

Course Objectives:

- To verify and demonstrate various theorems and resonance.
- To draw the locus diagram of series circuits
- To determine the various parameters of a two port networks
- To determine self and mutual inductance of a magnetic circuit, parameters of a given coil.
- To measure the power of three phase unbalanced circuit.

(Any 10 of the following experiments are to be conducted)

1. Verification of Kirchhoff's circuit laws.
2. Verification of Superposition theorem
3. Verification of Thevenin's and Norton's Theorems
4. Verification of Maximum power transfer theorem
5. Verification of Compensation theorem
6. Verification of Reciprocity and Millman's Theorems
7. Locus diagrams of R-L(L Variable) and R-C (C Variable) series circuits
8. Series and parallel resonance
9. Determination of self, mutual inductances and coefficient of coupling
10. Determination of Impedance (Z) and Admittance (Y) Parameters for a two port network
11. Determination of Transmission and Hybrid parameters
12. Determination of Parameters of a choke coil.
13. Determination of cold and hot resistance of an electric lamp.
14. Measurement of 3-phase power by two wattmeter method for unbalanced loads

Course Outcomes:
At the end of the course, student will be able to

- Apply various theorems
- Determination of self and mutual inductances
- Two port parameters of a given electric circuits
- Draw locus diagrams
- Draw Waveforms and phasor diagrams for lagging and leading networks

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II Year I Semester		L	T	P	C
		0	0	3	1.5
DC MACHINES AND TRANSFORMERS LAB					

Preamble:
The aim of the lab is to demonstrate the operation of various types of DC machines and transformers under no load and loaded conditions by conducting various tests and performance will be analyzed.

Course Objectives:
- To plot the magnetizing characteristics of DC shunt generator and understand the mechanism of self-excitation.
- To control the speed of DC motors.
- To determine and predetermine the performance of DC machines.
- To predetermine the efficiency and regulation of transformers and assess their performance.

(Any 10 of the following experiments are to be conducted)

1. Determination of critical field resistance and critical speed of DC shunt generator by using Magnetization characteristics
2. Predetermination of efficiency of DC Machine by conducting Swinburne's test
3. Performance characteristics of a DC shunt motor by conducting Brake test.
4. Predetermination of efficiency of two DC shunt machines by conducting Hopkinson's test
5. Speed control of DC shunt motor by Field and armature Control methods
6. Determination of constant losses of DC shunt motor by conducting Retardation test
7. Separation of losses (Eddy current and Hysteresis) in a DC shunt motor.
8. Predetermination of efficiency, regulation and to obtain the parameters of the equivalent circuit of a single phase transformer by conducting OC & SC tests.
9. Predetermination of efficiency, regulation and to obtain the parameters of the equivalent circuit of a single phase transformer by conducting Sumpner's test.
10. Conversion of three phase to two phase supply by using Scott connection of transformers
11. Parallel operation of two Single phase Transformers under no-load and load conditions
12. Separation of core losses of a single phase transformer
13. Heat run test on a bank of three single phase Delta connected transformers

Course Outcomes:
At the end of the course, student will be able to
- Determine and predetermine the performance of DC machines and Transformers.
- Control the speed of DC motor.
- Obtain three phase to two phase transformation.

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II Year I Semester		L	T	P	C
		0	0	3	1.5
ELECTRONIC DEVICES AND CIRCUITS LAB					

Preamble:
The aim of the lab imparts the knowledge to understand the concepts, working and characteristics of Different Diodes, BJT and FET Transistors, amplifiers and compensation techniques of transistors

Course Objectives: The student is able

- To study the characteristics of electronic components and measuring instruments.
- To understand the characteristics of PN, Zener diode, design rectifiers with and without filters
- To understand the characteristics of BJT, FET, MOSFET, SCR, UJT
- To understand the biasing of transistors
- To understand the frequency response of amplifiers, measure frequency, phase of signals.

Electronic Workshop Practice:

1. Identification, Specifications, Color Codes for resistor, R, L, C Components, Potentiometers, Coils, Gang condensers, Relays, Bread Boards.
2. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
3. Soldering Practice- Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital
5. Multimeter, Function Generator, Regulated Power Supply and CRO.

List of Experiments
(Any 10 of the following experiments are to be conducted)

1. P.N Junction Diode Characteristics
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
   Part A: V-I Characteristic
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
   Part A: Half-wave Rectifier
   Part B: Full-wave Rectifier
4. BJT Characteristics (CE Configuration)
   Part A: Input Characteristics
   Part B: output Characteristics
5. FET Characteristics
   Part A: Drain Characteristics
   Part B: Transfer Characteristics
6. SCR Characteristics

7. UJT Characteristics
8. MOSFET Characteristics
9. Transistor Biasing
10. Measurement of electrical quantities using CRO
11. BJT-CE Amplifier
12. Emitter Follower –CC Amplifier
13. FET-CS Amplifier

Note: The students are required to perform the experiment to obtain the V-I characteristics and to determine the relevant parameters from the obtained graphs.

Equipment required:

1. Regulated Power supplies
2. Analog/Digital Storage Oscilloscopes
3. Analog/Digital Function Generators
4. Digital Multi-meters
5. Decade Résistance Boxes/Rheostats
6. Decade Capacitance Boxes
7. Ammeters (Analog or Digital)
8. Voltmeters (Analog or Digital)
9. Active & Passive Electronic Components

Course Outcomes: At the end of the course, student will be able to

- Analyze the characteristics of diodes, transistors and other devices
- Design and implement the rectifier circuits, SCR and UJT in the hardware circuits.
- Design the biasing and amplifiers of BJT and FET amplifiers
- Measure electrical quantities using CRO in the experimentation.

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II Year I Semester		L	T	P	C
		0	**0**	4	**2**

SKILL ORIENTED COURSE
DESIGN OF ELECTRICAL CIRCUITS USING ENGINEERING SOFTWARE TOOLS

Preamble:
The aim of the course is to simulate various theorems and resonance. Also to determine self and mutual inductance of a magnetic circuit, parameters of a given coil through simulation.

Course Objectives:

- To Learn the fundamentals of MATLAB Tools
- To generate various waveform signals and sequences
- To verify and simulate various electrical circuits using Mesh and NodalAnalysis
- To verify and simulate various theorems
- To verify and simulate RLC series and parallel resonance.
- To determine self and mutual inductance of a magnetic circuit, parameters of agiven coil.

List of Experiments
(Any 10 of the following experiments are to be conducted)

Note: MATLAB/SMULINK fundamentals shall be explained during the first week before starting of the Lab course

1. Generation of various signals and sequences (Periodic and Aperiodic), such as unit Impulse, Step, Square, Saw tooth, Triangular, Sinusoidal, Ramp.
2. Operations on signals and sequences such as Addition, Multiplication, Scaling, Shifting, Folding, Computation of Energy, and Average Power
3. Verification of Kirchhoff's current law and voltage law using simulation tools.
4. Verification of mesh analysis using simulation tools.
5. Verification of nodal analysis using simulation tools.
6. Determination of average value, rms value, form factor, peak factor of sinusoidal wave, square wave using simulation tools.
7. Verification of super position theorem using simulation tools.
8. Verification of reciprocity theorem using simulation tools.
9. Verification of maximum power transfer theorem using simulation tools.
10. Verification of Thevenin's theorem using simulation tools.
11. Verification of Norton's theorem using simulation tools.
12. Verification of compensation theorem using simulation tools.
13. Verification of Milliman's theorem using simulation tools.
14. Verification of series resonance using simulation tools.
15. Verification of parallel resonance using simulation tools.
16. Verification of self inductance and mutual inductance by using simulation tools.

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Course Outcomes:

At the end of the course, student will be able to

- write the MATLAB programs to simulate the electrical circuit problems
- simulate various circuits for electrical parameters
- simulate various wave form for determination of wave form parameters
- simulate RLC series and parallel resonance circuits for resonant parameters
- simulate magnetic circuits for determination of self and mutual inductances

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II Year I Semester		L	T	P	C
		2	0	0	0
PROFESSIONAL ETHICS & HUMAN VALUES					

Preamble:
This course is a mandatory course introduced to impart the Ethics and Human Values to the students in engineering education.

Course Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty
- To appreciate the rights of others
- To create awareness on assessment of safety and risk

UNIT -I

Human Values:

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others –Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation– Commitment – Empathy –Self Confidence Character –Spirituality.

Learning outcomes:

1. Learn about morals, values & work ethics.
2. Learn to respect others and develop civic virtue.
3. Develop commitment
4. Learn how to live peacefully

UNIT -II

Engineering Ethics:

Senses of 'Engineering Ethics-Variety of moral issued –Types of inquiry –Moral dilemmas – Moral autonomy –Kohlberg's theory-Gilligan's Theory-Consensus and controversy –Models of professional roles-Theories about right action-Self-interest -Customs and religion –Uses of Ethical theories –Valuing time –Cooperation –Commitment.

Learning outcomes:

1. Learn about the ethical responsibilities of the engineers.
2. Create awareness about the customs and religions.
3. Learn time management
4. Learn about the different professional roles.

UNIT -III

Engineering as Social Experimentation:

Engineering As Social Experimentation –Framing the problem –Determining the facts – Codes of Ethics –Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons.

Learning outcomes:

1. Demonstrate knowledge to become a social experimenter.
2. Provide depth knowledge on framing of the problem and determining the facts.
3. Provide depth knowledge on codes of ethics.
4. Develop utilitarian thinking

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UNIT -IV

Engineers Responsibility for Safety and Risk:

Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights (IPR).

Learning outcomes:

1. Create awareness about safety, risk & risk benefit analysis.
2. Engineer's design practices for providing safety.
3. Provide knowledge on intellectual property rights.

UINIT- V

Global Issues:

Globalization –Cross-culture issues-Environmental Ethics –Computer Ethics –Computers as the instrument of Unethical behavior –Computers as the object of Unethical acts –Autonomous Computers-Computer codes of Ethics –Weapons Development -Ethics and Research –Analyzing Ethical Problems in research.

Learning outcomes:

1. Develop knowledge about global issues.
2. Create awareness on computer and environmental ethics
3. Analyze ethical problems in research.
4. Give a picture on weapons development.

Course outcomes:

Students will be able to:

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Text Books:

1) "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and, V.S.Senthil Kumar-PHI Learning Pvt. Ltd-2009
2) "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3) "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger –Tata McGraw-Hill–2003.
4) "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-Maruthi Publications.
5) "Professional Ethics and Human Values" by A.Alavudeen, R.KalilRahman and M. Jayakumaran, Laxmi Publications.
6) "Professional Ethics and Human Values" by Prof.D.R.Kiran-"Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

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II Year II Semester		L	T	P	C
		3	0	0	3
PYTHON PROGRAMMING					

Preamble:
This course is developed to impart the programming skills to the students and prepare them to suitable for industry ready

Course Objectives:
The Objectives of Python Programming are

- To learn about Python programming language syntax, semantics, and the runtime environment
- To be familiarized with universal computer programming concepts like data types, containers
- To be familiarized with general computer programming concepts like conditional execution, loops & functions
- To be familiarized with general coding techniques and object-oriented programming

UNIT-I

Introduction:
Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output.
Data Types, and Expression: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules.
Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.

UNIT- II
Control Statement:
Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration The While Loop
Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files.

UNIT -III
List and Dictionaries:
Lists, Defining Simple Functions, Dictionaries
Design with Function**:** Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function.
Modules: Modules, Standard Modules, Packages.

UNIT- IV

File Operations:

Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

Object Oriented Programming**:** Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using OOPs support

Design with Classes: Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism

UNIT -V

Errors and Exceptions:

Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions.

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

Programming**:** Introduction to Programming Concepts with Scratch.

Course Outcomes:

- Develop essential programming skills in computer programming concepts like data types, containers
- Apply the basics of programming in the Python language Solve coding tasks related
- conditional execution, loops
- Solve coding tasks related to the fundamental notions and techniques used in object- oriented programming

Text Books

1) Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage, 2/e, 2011.

Reference Books:

1) Introduction to Python Programming, Gowrishankar S., VeenaA, CRC Press, 2nd Edition, 2019.
2) Introduction to Programming Using Python, Y. Daniel Liang, Pearson, 1st Edition, 2012.

e-Resources:

1) https://www.tutorialspoint.com/python3/python_tutorial.pdf

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II Year II Semester		L	T	P	C
		3	0	0	3
DIGITAL ELECTRONICS					

Preamble:
This course covers the topics related to representation numbers in different radix formats, complements and codes. It also introduces the basic gates and their realization in SOP and POS form. Boolean algebra and various logic gates minimization process is introduced. Design principles of combinational and sequential circuits are explained to make the students thorough in design of these circuits.

Course Objectives:

- To solve a typical number base conversion and analyze new error coding techniques.
- Theorems and functions of Boolean algebra and behavior of logic gates.
- To optimize logic gates for digital circuits using various techniques.
- To understand concepts of combinational circuits.
- To develop advanced sequential circuits.

UNIT - I
Review of Number Systems & Codes:
Representation of numbers of different radix, conversion from one radix to another radix, r-1's complements and r's complements of signed members. Gray code,4 bit codes; BCD, Excess-3, 2421, 84-2-1 code etc., Error detection & correction codes: parity checking, even parity, odd parity, Hamming code.
Boolean theorems and logic operations
Boolean theorems, principle of complementation & duality, De-Morgan theorems. Logic operations; Basic logic operations -NOT, OR, AND, Universal Logic operations, EX-OR, EX-NOR operations. Standard SOP and POS Forms, NAND-NAND and NOR-NOR realizations.

UNIT - II
Minimization Techniques:
Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method.
Combinational Logic Circuits Design:
Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4-bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-a-head adder circuit

UNIT - III
Combinational Logic Circuits Design Using MSI &LSI:
Design of encoder, decoder, multiplexer and demultiplexers, Implementation of higher order circuits using lower order circuits. Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder
Introduction of PLD's:
PLDs: PROM, PAL, PLA -Basics structures, realization of Boolean functions.

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UNIT - IV

Sequential Circuits-I:

Classification of sequential circuits (synchronous and asynchronous) , operation of NAND & NOR Latches and flip-flops; truth tables and excitation tables of RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals. Conversion from one flip-flop to another flip-flop. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift register.

UNIT - V

Sequential Circuits -II:

Finite state machine; state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa. Realization of sequence generator and sequence detector circuits, Races and Hazards.

Course Outcomes: At the end of the course, student will be able to

- Classify different number systems and apply to generate various codes.
- Use the concept of Boolean algebra in minimization of switching functions
- Design different types of combinational logic circuits.
- Apply knowledge of flip-flops in designing of Registers and counters
- The operation and design methodology for synchronous sequential circuits and algorithmic state machines.

Text Books:

1. Switching and finite automata theory:ZviKohavi, Niraj K. Jha,Cambridge University Press, 3rd Edition, 2009.
2. Digital Design by Morris Mano, Prentice Hall India, 5th Edition.

Reference Books:

1. Digital Principles and Applications by Leach , Malvino , Saha, Mc-Graw Hill, 8th Edition, 2014.
2. Switching Theory and Logic Design by A. Anand Kumar, PHI learning, 3rd edition.
3. Introduction to Switching Theory and Logic Design – Fredriac J Hill, Gerald R Peterson, 3rdEdition, John Willey and Sons Inc,
4. Fundamentals of Logic Design by Charles H. RothJr., Cengage Learning, 7th edition,2013.

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II Year II Semester		L	T	P	C
		3	0	0	3
POWER SYSTEMS - I					

Preamble:
Electrical Power plays significant role in day-to-day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

Course Objectives:

- To study the principle of operation of different components of a thermal power stations.
- To study the principle of operation of different components of a Nuclear power stations.
- To study the constructional and operation of different components of an Air and Gas Insulated substations.
- To study the constructional details of different types of cables.
- To study different types of load curves and tariffs applicable to consumers.

UNIT - I
Hydroelectric Power Stations:
Selection of site, general layout of a hydroelectric power plant with brief description of major components and principle of operation
Thermal Power Stations
Selection of site, general layout of a thermal power plant. Brief description of components: boilers, super heaters, economizers and electrostatic precipitators, steam turbines: impulse and reaction turbines, condensers, feed water circuit, cooling towers and chimney.

UNIT - II
Nuclear Power Stations
Location of nuclear power plant, working principle, nuclear fission, nuclear fuels, nuclear chain reaction, nuclear reactor components: moderators, control rods, reflectors and coolants, types of nuclear reactors and brief description of PWR, BWR and FBR. Radiation: radiation hazards and shielding, nuclear waste disposal.

UNIT - III
Classification of Air and Gas Insulated substations
Air Insulated Substations – indoor & outdoor substations, substations layouts of 33/11 kV showing the location of all the substation equipment.

Bus bar arrangements in the sub-stations: simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.
Gas Insulated Substations (GIS) – advantages of gas insulated substations, constructional aspects of GIS, installation and maintenance of GIS, comparison of air insulated substations and gas insulated substations.

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UNIT- IV

Underground Cables

Types of cables, construction, types of insulating materials, calculation of insulation resistance, stress in insulation and power factor of cable.

Capacitance of single and 3-Core belted Cables. Grading of cables: capacitance grading and intersheath grading.

UNIT - V

Economic Aspects of Power Generation & Tariff

Economic Aspects – load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor and plant use factor, base and peak load plants.

Tariff Methods– costs of generation and their division into fixed, semi-fixed and running costs, desirable characteristics of a tariff method, tariff methods: simple rate, flat rate, block-rate, two-part, three–part, and power factor tariff methods.

Course Outcomes:

At the end of the course, student will be able to

- Identify the different components of thermal power plants.
- Identify the different components of nuclear Power plants.
- Identify the different components of air and gas insulated substations.
- Identify single core and three core cables with different insulating materials.
- Analyse the different economic factors of power generation and tariffs.

Text Books:

1. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagarand A. Chakrabarti, DhanpatRai& Co. Pvt. Ltd, 2016.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa, New age International (P) Limited, Publishers, 3rd edition.

Reference Book:

1. Elements of Electrical Power Station Design by M V Deshpande, PHI, New Delhi, 2009.

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II Year II Semester		L	T	P	C
		3	0	0	3
INDUCTION AND SYNCHRONOUS MACHINES					

Preamble:
This course covers the topics on 3-phase induction motor, 1-phase induction motor and synchronous machines which have wide application in power systems. The main aim of the course is to provide a detailed analysis of operation and performance of 3-phase induction motor, 1-phase induction motor and synchronous machines. In addition, it also covers voltage regulation and parallel operation of synchronous generators.

Course Objectives:

- Understand the principle of operation and performance of 3-phase induction motor.
- Quantify the performance of induction motor and induction generator in terms of torque and slip.
- To understand the torque producing mechanism of a single phase induction motor.
- To understand the principle of emf generation, the effect of armature reaction and predetermination of voltage regulation in synchronous generators.
- To study parallel operation and control of real and reactive powers for synchronous generators.
- To understand the operation, performance and starting methods of synchronous motors.

UNIT - I
3-phase induction motors
Construction details of squirrel cage and slip ring induction motors – production of rotating magnetic field – principle of operation – Equivalent circuit –phasor diagram- slip speed-rotor emf and rotor frequency – rotor current and pf at standstill and during running conditions – rotor power input, rotor copper loss and mechanical power developed and their interrelationship.

UNIT - II
Characteristics and testing methods of induction motors
Torque equation – expressions for maximum torque and starting torque – torque slip characteristic – double cage and deep bar rotors – crawling and cogging – speed control of induction motor with V/f control method – no load and blocked rotor tests – circle diagram for predetermination of performance – induction generator operation (Qualitative treatment only)

UNIT - III
Starting methods of 3-phase induction motors
Methods of starting of three phase Induction motors: DOL, Auto transformer, Star-Delta and rotor resistance methods.

Single phase induction motors:
Constructional features- equivalent circuit- problem of starting-double revolving field theory-Methods of starting. AC series motors.

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UNIT - IV

Construction, operation, voltage regulation and parallel operation of synchronous generator:

Constructional features of non-salient and salient pole machines –types of armature windings – distribution, pitch and winding factors – E.M.F equation –improvements of waveform and armature reaction –phasor diagrams- voltage regulation by synchronous impedance method – MMF method and Potier triangle method– two reaction analysis of salient pole machines and phasor diagram.

Parallel operation with infinite bus and other alternators – synchronizing power – load sharing – control of real and reactive power – numerical problems.

UNIT - V

Synchronous motor – operation, starting and performance

Synchronous motor principle and theory of operation – phasor diagram – starting torque – variation of current and power factor with excitation – capability curves - synchronous condenser – mathematical analysis for power developed – hunting and its suppression – methods of starting – applications.

Course Outcomes: At the end of the course, student will be able to

- Explain the operation and performance of three phase induction motor.
- Analyze the torque-speed relation, performance of induction motor and induction generator.
- Implement the starting of single phase induction motors.
- Develop winding design and predetermine the regulation of synchronous generators.
- Explain hunting phenomenon, implement methods of staring and correction of power factor with synchronous motor.

Text Books:

1. Electrical Machines by P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald, Charles Kingsley, Stephen D.Umans, TMH

Reference Books:

1. 1.Performance and design of AC machines – M.G. Say
2. Alternating Current Machines by A.F.Puchstein, T.C. Lloyd, A.G. Conrad, ASIA Publishing House
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education, 2010.
4. Electrical Machines by R.K.Rajput, Lakshmi publications, 5th edition

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II Year II Semester		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS & FINANCIAL ANALYSIS					

Course Objectives:

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand-Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Theories of Production and Cost Analyses:

Theories of Production function- Law of Variable Proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit Analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles: Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.

Unit – IV:

Introduction to Accounting & Financing Analysis:

Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

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Unit – V:

Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods (payback period, accounting rate of return) and modern methods (Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

Text Books:

1. Managerial Economics and Financial Analysis by A R Aryasri, McGraw – Hill, 3rd edition.

References Books:

1. Managerial Economics by Varshney R.L, K.L Maheswari, S. Chand & Company Ltd,
2. Managerial Economics, JL Pappas and EF Brigham, Holt, R & W; New edition.
3. Accounting for Management, N.P Srinivasn and M. Sakthivel Murugan, S. Chand & Company Ltd, 1st edition, 2011.
4. An Introduction to Accountancy by Maheswari S.N, Vikas Publishing House Pvt Ltd, 12th edition, 2018.
5. Financial Management by I.M Pandey, Vikas Publishing House Pvt Ltd, 9th edition, 2009.
6. Managerial Economics by V. Maheswari, S. Chand & Company Ltd, 2002.

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II Year II Semester		L	T	P	C
		0	0	3	1.5
PYTHON PROGRAMMING LAB					

Preamble:

This lab is designed to impart the advanced programming skills to the students and prepare them to suitable for industry ready

Course Objectives:
The aim of Python Programming Lab is

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python
- To develop the skill of designing Graphical user Interfaces in Python
- To develop the ability to write database applications in Python

1) Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
2) Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
3) Write a program that uses a *for* loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86,89.
4) Writeaprogramthatasks theuserfortheirnameandhowmanytimestoprintit.The program should print out the user's name the specified number of times.
5) Use a *for* loop to print a triangle like the one below. Allow the user to specify how high the triangle should be.

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*
**
***
****
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6) Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.
7) Write a program that asks the user for two numbers and prints *Close* if the numbers are within .001 of each other and Not close otherwise.
8) Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
9) Write a program that asks the user to enter two strings of the same length. The program should then check to see if the strings are of the same length. If they are not, the program should print an appropriate message and exit. If they are of the same length, the program should alternate the characters of the two strings. For example, if the user enters *abcde* and *ABCDE* the program should print out*AaBbCcDdEe*.
10) Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers. For instance, if the user enters 1000000, the output should be1,000,000.

11) In algebraic expressions, the symbol for multiplication is often left out, as in 3x+4y or 3(x+5). Computers prefer those expressions to include the multiplication symbol, like 3*x+4*y or 3*(x+5). Write a program that asks the user for an algebraic expression and then inserts multiplication symbols where appropriate.
12) Write a program that generates a list of 20 random numbers between 1 and100.
    (a) Print the list.
    (b) Print the average of the elements in the list.
    (c) Print the largest and smallest values in the list.
    (d) Print the second largest and second smallest entries in the list
    (e) Print how many even numbers are in the list.
13) Write a program that asks the user for an integer and creates a list that consists of the factors of that integer.
14) Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row. For instance, the longest run of zeros in [1,0,1,1,0,0,0,0,1,0,0] is4.
15) Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become[1,2,3,4,0].
16) Write a program that asks the user to enter a length in feet. The program should then give the user the option to convert from feet into inches, yards, miles, millimeters, centimeters, meters, or kilometers. Say if the user enters a 1, then the program converts to inches, if they enter a 2, then the program converts to yards, etc. While this can be done with if statements, itis much shorter with lists and it is also easier to add new conversions if you use lists.
17) Write a function called *sum_digits* that is given an integer num and returns the sum of the digits of num.
18) Write a function called *first_diff* that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return-1.
19) Write a function called *number_of_factors* that takes an integer and returns how many factors the number has.

20) Write a function called *is_sorted* that is given a list and returns True if the list is sorted and False otherwise.
21) Write a function called root that is given a number x and an integer n and returns $x^{1/n}$. In the function definition, set the default value of n to2.
22) Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be100.
23) Write a function called merge that takes two already sorted lists of possibly different lengths, and merges them into a single sorted list.
    (a) Do this using the sort method. (b) Do this without using the sort method.
24) Write a program that asks the user for a word and finds all the smaller words that can be made from the letters of that word. The number of occurrences of a letter in a smaller word can't exceed the number of occurrences of the letter in the user's word.
25) Write a program that reads a file consisting of email addresses, each on its own line. Your program should print out a string consisting of those email addresses separated by semicolons.

26) Write a program that reads a list of temperatures from a file called *temps.txt*, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.
27) Write a class called Product. The class should have fields called name, amount, and holding the product's name, the number of items of that product in stock, and the regular price of the product. There should be a method *get_price* that receives the number of items to be bought and returns a the cost of buying that many items, where the regular price is charged for orders of less than 10 items, a 10% discount is applied for orders of between 10 and 99 items, and a 20% discount is applied for orders of 100 or more items. There should also be a method called *make_purchase* that receives the number of items to be bought and decreases amount by that much.
28) Write a class called Time whose only field is a time in seconds. It should have a method called *convert_to_minutes* that returns a string of minutes and seconds formatted as in the following example: if seconds is 230, the method should return '5:50'. It should also have a method called *convert_to_hours* that returns a string of hours, minutes, and seconds formatted analogously to the previous method.
29) Write a class called Converter. The user will pass a length and a unit when declaring an object from the class for example, c = Converter(9,'inches'). The possible units are inches, feet, yards, miles, kilometers, meters, centimeters, and millimeters. For each of these units there should be a method that returns the length converted into those units. For example, using the Converter object created above, the user could call c. feet() and should get 0.75 as the result.
30) Write a Python class to implement pow(x,n).
31) Write a Python class to reverse a string word byword.
32) Write a program that opens a file dialog that allows you to select a text file. The program then displays the contents of the file in a textbox.
33) Write a program to demonstrate Try/except/else.
34) Write a program to demonstrate try/finally and with/as.

Course Outcomes:

By the end of this lab, the student is able to

- Write, Test and Debug Python Programs
- Use Conditionals and Loops for Python Programs
- Use functions and represent Compound data using Lists, Tuples and
- Dictionaries Use various applications using python

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II Year II Semester		L	T	P	C
		0	0	3	1.5
INDUCTION AND SYNCHRONOUS MACHINES LAB					

Preamble:
The aim of the lab is to provide a detailed analysis of operation and performance of 3-phase induction motor, 1-phase induction motor and synchronous machines. In addition, it also covers voltage regulation and parallel operation of synchronous generators.

Course Objectives:
The students are able to understand the,

- Speed control methods of three-phase induction motors.
- Performance characteristics of three-phase and single-phase induction motors.
- Principles of power factor improvement of single-phase induction motor.
- Voltage regulation calculations of three–phase alternator by various methods,
- Performance curves of three-phase synchronous motor.

(Any 10 of the following experiments are to be conducted)

1. Performance characteristics of a three- phase Induction Motor by conducting Brake test
2. Determination of equivalent circuit parameters, efficiency and regulation of a three phase Induction motor by conducting No–load & Blocked rotor tests
3. Determination of Regulation of a three–phase alternator by using synchronousimpedance & m.m.f. methods
4. Determination of Regulation of a three–phase alternator by using Potier triangle method
5. Determination of V and Inverted V curves of a three phase synchronous motor.
6. Determination of X_d and X_q of a salient pole synchronous machine
7. Speed control of three phase induction motor by V/f method.
8. Determination of equivalent circuit parameters of single phase induction motor
9. Determination of efficiency of three-phase alternator by loading with three phaseinduction motor.
10. Power factor improvement of single-phase induction motor by using capacitors.
11. Parallel operation of three-phase alternator under no-load and load conditions
12. Determination of efficiency of a single-phase AC series Motor by conducting Brake test.
13. Starting of single-phase Induction motor by using capacitor start and capacitor startrun methods.
14. Determination of efficiency of a single-phase Induction Motor by conducting Brake test.

Course Outcomes:
At the end of the course, student will be able to

- Assess the performance of single phase and three phase induction motors.
- Control the speed of three phase induction motor.
- Predetermine the regulation of three–phase alternator by various methods.
- Find the X_d/X_q ratio of alternator and asses the performance of three–phase synchronous motor.
- Determine the performance of single phase AC series motor.

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II Year II Semester		L	T	P	C
		0	0	3	1.5
DIGITAL ELECTRONICS LAB					

Preamble:
The aim of this lab is to understand the Basics of digital electronics and able to design basic logic circuits, combinational and sequential circuits.

Course Objectives:

- To know the concept of Boolean laws for simplifying the digital circuits.
- To understand the concepts of flipflops.
- To understand the concepts of counters.
- To analyze and design various circuits.

List of Experiments:

Any TEN of the following Experiments are to be conducted

1. Verification of truth tables of Logic gates: Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive OR (vi) Exclusive NOR
2. Design a simple combinational circuit and obtain minimal SOP expression and verify the truth table using Digital Trainer Kit
3. Verification of functional table of 3 to 8 line Decoder / De-multiplexer
4. 4 variable logic function verification using 8 to 1 multiplexer.
5. Design full adder circuit and verify its functional table.
6. Design full Subtractor circuit and verify its functional table.
7. Verification of functional tables of Flip-Flops
8. Design a four bit ring counter using D Flip – Flops / JK Flip Flop and verify output
9. Design a four bit Johnson's counter using D Flip-Flops / JK Flip Flops and verify output
10. Draw the circuit diagram of MOD-8 ripple counter and construct a circuit using T-Flip-Flops and Test it with a low frequency clock and Sketch the output waveforms.
11. Design MOD – 10 ripple counter using T- Flip-Flop and verify the result and Sketch the output waveforms
12. Design MOD – 8 synchronous counter using D Flip-Flop and verify the result and Sketch the output waveforms.

Course Outcomes: At the end of the course, student will be able to

- Learn the basics of gates, filp-flops and counters.
- Construct basic combinational circuits and verify their functionalities
- Apply the design procedures to design basic sequential circuits
- To understand the basic digital circuits and to verify their operation
- Apply Boolean laws to simplify the digital circuits.

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II Year II Semester		L	T	P	C
		0	**0**	4	2
SKILL ORIENTED COURSE **IOT APPLICATIONS OF ELECTRICAL ENGINEERING**					

Preamble:
The aim of this course is to introduce Internet of Things to simulate real time applicationsusing Arduino/Raspberry Pi.

Course Objectives:
- To understand fundamentals of various technologies of Internet of Things.
- To know various communication technologies used in the Internet of Things.
- To know the connectivity of devices using web and internet in the IoT environment.
- To understand the implementation of IoT by studying case studies like Smart Home, Smart city, etc.

List of Experiments:

Any TEN of the following Experiments are to be conducted

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface temperature sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface Organic Light Emitting Diode (OLED) with Arduino/Raspberry Pi
6. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when ‘1’/’0’ is received from smartphone using Bluetooth.
8. Write a program on Arduino/Raspberry Pi to upload and retrieve temperature and humidity data to thingspeak cloud.
9. 7 Segment Display
10. Analog Input & Digital Output
11. Night Light Controlled & Monitoring System
12. Fire Alarm Using Arduino
13. IR Remote Control for Home Appliances
14. A Heart Rate Monitoring System
15. Alexa based Home Automation System

Course Outcomes:
After the completion of the course the student should be able to:
- apply various technologies of Internet of Things to real time applications.
- apply various communication technologies used in the Internet of Things.
- connect the devices using web and internet in the IoT environment.
- implement IoT to study Smart Home, Smart city, etc.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
POWER SYSTEMS–II					

Preamble:
This course is an extension of power systems–I course. It deals with basic theory of transmission lines modeling and their performance analysis. Transients in power system and effects of corona are discussed in detail. It is important for the student to understand the mechanical design aspects of transmission lines, insulators. These aspects are also covered in detail in this course.

Course Objectives:
- To understand the concepts of GMD/GMR and to compute inductance/capacitance of transmission lines.
- To distinguish the short and medium length transmission lines, their models and performance.
- To understand the performance and modeling of long transmission lines.
- To learn the effect of travelling waves on transmission lines.
- To learn the concepts of corona and the factors effecting corona..
- To understand sag and tension computation of transmission lines as well as to learn the performance of overhead insulators.

UNIT–I
Transmission Line Parameters
Conductor materials – Types of conductors – Calculation of resistance for solid conductors – Skin and Proximity effects – Calculation of inductance for Single-phase and Three-phase– Single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors – Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and Three-phase–Single and double circuit lines without and with Bundled conductors.

UNIT–II
Performance Analysis of Transmission Lines
Classification of Transmission Lines – Short, medium, long lines and their model representation – Nominal-T, Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks.
Rigorous Solution for long line equations –Representation of Long lines – Equivalent T and Equivalent Pie network models - Surge Impedance and Surge Impedance Loading (SIL) of Long Lines - Regulation and efficiency for all types of lines – Ferranti effect.

UNIT – III
Power System Transients
Types of System Transients – Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients.

Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction – Lumped Reactive Junctions.

UNIT–IV
Corona
Description of the phenomenon – Types of Corona - critical voltages and power loss – Advantages and Disadvantages of Corona - Factors affecting corona - Radio Interference.

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UNIT–V

Sag and Tension Calculations and Overhead Line Insulators:

Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor – Stringing chart and sag template and its applications

Types of Insulators – String efficiency and Methods for improvement - Voltage distribution–Calculation of string efficiency – Capacitance grading and Static Shielding.

Course Outcomes:

After the completion of the course the student should be able to:

- Calculate parameters of transmission lines for different circuit configurations.
- Determine the performance of short, medium and long transmission lines.
- Analyse the effect of travelling waves on transmission lines.
- Analyse the various voltage control methods and effect of corona.
- Calculate sag/tension of transmission lines and performance of line insulators.

Text Books:

1. Electrical Power Systems – by C.L.Wadhwa, New Age International (P) Limited, 1998.
2. Power System Engineering by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 3rd Edition.

Reference Books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar A.Chakrabarthy, DhanpatRai Co Pvt. Ltd.2016
4. Electrical Power Systems by P.S.R. Murthy, B.S. Publications, 2017.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
POWER ELECTRONICS					

Preamble:
The usage of power electronics in day to day life has increased in recent years. It is important for student to understand the fundamental principles behind all power electronic converters. This course covers characteristics of semiconductor devices and operation of ac/dc, dc/dc, ac/ac and dc/ac converters. The importance of using pulse width modulated techniques to obtain high quality power supply (dc/ac converter) is also discussed in detail in this course.

Course Objectives:
- To know the characteristics of various power semiconductor devices.
- To learn the operation of single phase full–wave converters and perform harmonic analysis of input current.
- To learn the operation of three phase full–wave converters and AC/AC converters.
- To learn the operation of different types of DC-DC converters.
- To learn the operation of PWM inverters for voltage control and harmonic mitigation.

UNIT – I
Power Semi-Conductor Devices
Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics – Turn on and Turn off Methods - Triggering Methods (R, RC and UJT) – Snubber circuit design.
Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems.

UNIT – II
Single-phase AC-DC Converters
Single-phase half-wave controlled rectifiers - R and RL loads with and without freewheeling diode - Single-phase fully controlled mid-point and bridge converter with R load, RL load and RLE load - Continuous and Discontinuous conduction - Effect of source inductance in Single-phase fully controlled bridge rectifier – Expression for output voltages – Single-phase Semi-Converter with R load-RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis – Dual converter and its mode of operation - Numerical Problems.

UNIT – III
Three-phase AC-DC Converters & AC – AC Converters
Three-phase half-wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Harmonic Analysis - Three-phase Dual Converters - Numerical Problems.
Single-phase AC-AC power control by phase control with R and RL loads - Expression for rms output voltage – Single-phase step down and step up Cycloconverter - Numerical Problems.

UNIT – IV
DC–DC Converters
Operation of Basic Chopper – Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple – control techniques – Introduction to PWM control -Numerical Problems.

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UNIT – V

DC–AC Converters

Introduction - Single-phase half-bridge and full-bridge inverters with R and RL loads – Phase Displacement Control – PWM with bipolar voltage switching, PWM with unipolar voltage switching - Three-phase square wave inverters - 120^0 conduction and 180^0 conduction modes of operation - Sinusoidal Pulse Width Modulation - Current Source Inverter (CSI) - Numerical Problems.

Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate the static and dynamic characteristics of SCR, Power-MOSFET and Power-IGBT.
- Analyse the operation of phase-controlled rectifiers.
- Analyse the operation of three-phase full–wave converters, AC Voltage Controllers and Cycloconverters.
- Examine the operation and design of different types of DC-DC converters.
- Analyse the operation of PWM inverters for voltage control and harmonic mitigation.

Text Books:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, John Wiley & Sons.
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998
3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. Oxford University Press; Second edition
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics: by Daniel W.Hart, Mc Graw Hill.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
CONTROL SYSTEMS					

Preamble:
This course covers mathematical modeling, time response, frequency response, stability analysis of Linear Time Invariant (LTI) control systems and their analysis. State space analysis of LTI systems and design of compensator using Bode diagrams is also discussed in this course.

Course Objectives:
- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance using PI, PD, PID controllers. To investigate the stability of closed loop systems using Routh's stability criterion and root locus method.
- To understand basic aspects of design and compensation of LTI systems using Bode diagrams.
- To learn Frequency Response approaches for the analysis of LTI systems using Bode plots, polar plots and Nyquist stability criterion.
- To learn state space approach for analysis of LTI systems and understand the concepts of controllability and observability.

UNIT – I
Mathematical Modelling of Control Systems
Classification of control systems - open loop and closed loop control systems and their differences - Feedback characteristics - transfer function of linear system, differential equations of electrical networks- translational and rotational mechanical systems - transfer function of Armature voltage controlled DC servo motor - block diagram algebra - signal flow graph – reduction using Mason's gain formula.

UNIT-II
Time Response Analysis and Controllers
Standard test signals – time response of first and second order systems – time domain specifications - steady state errors and error constants - effects of proportional (P) - proportional integral (PI) - proportional derivative (PD) - proportional integral derivative (PID) systems.
Stability Assessment Techniques
The concept of stability – Routh's stability criterion – limitations of Routh's stability, root locus concept – construction of root loci (simple problems) - Effect of addition of Poles and Zeros to the transfer function.

UNIT–III
Frequency Response Analysis
Introduction to frequency domain specifications – Bode diagrams – transfer function from the Bode diagram –Polar plots, Nyquist stability criterion- stability analysis using Bode plots (phase margin and gain margin).

UNIT–IV
Classical Control Design Techniques
Lag, lead, lag-lead compensators - physical realisation - design of compensators using Bode plots.

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UNIT–V

State Space Analysis of Linear Time Invariant (LTI) Systems

Concepts of state - state variables and state model - state space representation of transfer function - diagonalization using linear transformation - solving the time invariant state equations - State Transition Matrix and its properties- concepts of controllability and observability.

Course Outcome:

After the completion of the course the student should be able to:

- Derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- Determine time response specifications of second order systems and absolute and relative stability of LTI systems using Routh's stability criterion and root locus method.
- Analyze the stability of LTI systems using frequency response methods.
- Design Lag, Lead, Lag-Lead compensators to improve system performance using Bode diagrams.
- Represent physical systems as state models and determine the response. Understand the concepts of controllability and observability.

Text Books:

1. Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of India
2. Automatic control systems by Benjamin C.Kuo, Prentice Hall of India, 2nd Edition.

Reference Books:

1. Control Systems principles and design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4th Edition.
2. Control Systems Engineering by Norman S. Nise, Wiley Publications, 7th edition
3. Control Systems by Manik Dhanesh N, Cengage publications.
4. Control Systems Engineering by I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.

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III Year –I SEMESTER		L	T	P	C
		3	0	0	3
RENEWABLE ENERGY SOURCES (OPEN ELECTIVE-I)					

Preamble:
This course presents the various sources of renewable energy such as solar, wind, geothermal energy, biomass & other potential energy and contribution towards energy profile of the nation.

Course Objectives:
- To study the solar radiation data, equivalent circuit of PV cell and its I-V & P-V characteristics.
- To understand the concept of Wind Energy Conversion & its applications.
- To study the principles of biomass and geothermal energy.
- To understand the principles of Ocean Thermal Energy Conversion (OTEC), motion of waves and power associated with it.
- To study the various chemical energy sources such as fuell cell and hydrogen energy along with their operation and equivalent circuit.

UNIT–I
Solar Energy: Introduction - Renewable Sources - prospects, Solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house.

UNIT–II
Wind Energy: Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications.

UNIT–III
Biomass and Geothermal Energy:
Biomass: Introduction - Biomass conversion technologies - Photosynthesis, factors affecting Bio digestion - classification of biogas plants - Types of biogas plants - selection of site for a biogas plant
Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems.

UNIT–IV
Energy From oceans, Waves & Tides:
Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.
Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.
Tides: Basic principle of Tide Energy -Components of Tidal Energy.

UNIT–V
Chemical Energy Sources:
Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.
Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications
Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

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Course Outcomes:

After the completion of the course the student should be able to:

- Analyze solar radiation data, extra-terrestrial radiation, radiation on earth's surface and solar Energy Storage.
- Illustrate the components of wind energy systems.
- Illustrate the working of biomass, digesters and Geothermal plants.
- Demonstrate the principle of Energy production from OTEC, Tidal and Waves.
- Evaluate the concept and working of Fuel cells & MHD power generation.

Text Books:

1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
2. John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

1. S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
3. Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3

CONCEPTS OF OPTIMIZATION TECHNIQUES
(OPEN ELECTIVE-I)

Preamble:

The applications of optimization techniques have expanded in all fields including design aspects of electrical machines. It is pertinent to link these concepts with that of programming skills. This course covers basic features of linear & nonlinear programming problems. Concept of dynamic programming and transportation problem are also taught.

Course Objectives:

- To know the importance of adopting optimization techniques in day to day life.
- To analyse the importance of various types of constraints at various stages.
- To learn more on linear & nonlinear programming concepts.
- To analyse the significance of transportation problem.
- To learn the concepts of dynamic programming.

UNIT – I
Introduction to Optimization Techniques
Statement of an Optimization problem – design vector – design constraints – objective function – classification of Optimization problems.
Classical Optimization Techniques
Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers.

UNIT – II
Linear Programming
Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

UNIT – III
Nonlinear Programming
Unconstrained cases - One – dimensional minimization methods: Classification - Fibonacci method and Quadratic interpolation method - Univariate method - Powell's method.
Constrained cases - Characteristics of a constrained problem - Classification - Basic approach of Penalty Function method.

UNIT – IV
Transportation Problem
Finding initial basic feasible solution by north – west corner rule - least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems – Special cases in transportation problem.

UNIT – V
Dynamic Programming
Dynamic programming - Multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution.

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Course Outcomes:

After the completion of the course the student should be able to:

- State and formulate the optimization problem without and with constraints, also apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Formulate a mathematical model and apply non-linear programming techniques for unconstrained and constrained case studies.
- Solve transportation and assignment problem by using Linear programming Simplex method.
- Formulate and apply Dynamic programming technique to inventory control, production planning, engineering design problems etc. to reach a final optimal solution from the current optimal solution.

Text Books:

1. "Engineering optimization: Theory and practice"-by S. S.Rao- New Age International (P) Limited - 3rd edition - 1998.
2. "Introductory Operations Research" by H.S. Kasene& K.D. Kumar - Springer (India) 2013.

Reference Books:

1. "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan - New Age International (P) Limited - Publishers - 3rd edition - 1996.
2. Operations Research – by Dr. S.D.Sharma- Kedarnath - Ramnath& Co - 2012.
3. "Operations Research: An Introduction" – by H.A.Taha - PHI pvt. Ltd. - 6th edition
4. Linear Programming–by G.Hadley.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
CONCEPTS OF CONTROL SYSTEMS (OPEN ELECTIVE-I)					

Preamble:
This course covers mathematical modeling, time response, frequency response, stability analysis of Linear Time Invariant (LTI) control systems and their analysis. State space analysis of LTI systems and design of compensator using Bode diagrams is also discussed in this course.

Course Objectives:
- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance using PI, PD, PID controllers.
- To investigate the stability of closed loop systems using Routh's stability criterion and root locus method.
- To learn Frequency Response approaches for the analysis of LTI systems using Bode plots, polar plots and Nyquist stability criterion.
- To learn state space approach for analysis of LTI systems and understand the concepts of controllability and observability.

UNIT – I
Mathematical Modelling of Control Systems
Classification of control systems - open loop and closed loop control systems and their differences - transfer function of linear system - differential equations of electrical networks - translational and rotational mechanical systems – block diagram algebra – Feedback characteristics.

UNIT-II
Time Response Analysis
Standard test signals – time response of first and second order systems – time domain specifications - steady state errors and error constants - P - PI & PID Controllers.

UNIT–III
Stability and Root Locus Technique
The concept of stability – Routh-Hurwitz Criteria – limitations of Routh-Hurwitz criterion-.Root locus concept – construction of root loci (simple problems).

UNIT–IV
Frequency Response Analysis
Introduction to frequency domain specifications – Bode diagrams – Transfer function from the Bode diagram – phase margin and gain margin.

UNIT–V
State Space Analysis of Linear Time Invariant (LTI) Systems
Concepts of state - state variables and state model - state space representation of transfer function - State Transition Matrix and it's properties - concepts of controllability and observability.

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Course Outcomes:

After the completion of the course the student should be able to:

- Derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- Determine time response specifications of second order systems and to determine error constants.
- Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- Analyze the stability of LTI systems using frequency response methods.
- Represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:

1. Modern Control Engineering by Kotsuhiko Ogata - Prentice Hall of India.
2. Automatic control systems by Benjamin C.Kuo - Prentice Hall of India - 2nd Edition.

Reference Books:

1. Control Systems principles and design by M.Gopal - Tata Mc Graw Hill education Pvt Ltd. - 4th Edition.
2. Control Systems by Manik Dhanesh N - Cengage publications.
3. Control Systems Engineering by I.J.Nagarath and M.Gopal - Newage International Publications - 5th Edition.
4. Control Systems Engineering by S.Palani - Tata Mc Graw Hill Publications.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
LINEAR IC APPLICATIONS (PROFESSIONAL ELECTIVE – I)					

Unit – I

OP-Amp Block Diagram (Symbolic Representation), Characteristics of Op-Amp, Ideal and Practical Op-Amp specifications, DC and AC Characteristics, Definitions of Input and Output Off-set voltage and currents slow rate, CMRR, PSRR. Measurements of Op-Amp Parameters, Three-Terminal Voltage Regulators 78xx& 79xx Series, current Booster, adjustable voltage, DualPowerSupplywith78xx&79xx

Unit – II

OP-AMPS Applications: Introduction, Basic Op-Amp Applications, Instrumentation Amplifier, AC Amplifier, V to I and I to V Converter, Sample and Hold Circuit, Log and Antilog Amplifier, Multiplier and Divider, Differentiator, integrator.

Comparators and Waveform Generators: Introduction, Comparator, Square Wave Generator, Monostable Multivibrator, Triangular Wave Generator, Sine Wave Generators.

Unit – III

Active Filters:

Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.

Unit – IV

Timers: Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger.

Phase Locked Loops: Introduction, block schematic, principles and description of individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation, AM, FM & FSK demodulators. Applications of VCO (566)

Unit – V

Digital To Analog And Analog To Digital Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A-D Converters – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC.DAC and ADC Specifications.

Course Outcomes:

At the end of the course, student will be able to:

- Describe the Op-Amp and internal Circuitry: 555 Timer, PLL
- Discuss the Applications of Operational amplifier: 555 Timer, PLL
- Design the Active filters using Operational Amplifier
- Use the Op-Amp in A to D & D to A Converters

Text Books:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition 2003.
2. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma; SK Kataria & Sons; 2nd Edition, 2010

References:

1. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI, 1993.
2. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition.

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III Year –I SEMESTER		L	T	P	C
		3	0	0	3

UTILIZATION OF ELECTRICAL ENERGY
(PROFESSIONAL ELECTIVE – I)

Preamble:
This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives. Another major share of loads is taken by Electric Traction. Utilization of electrical energy in all the above loads is discussed in detail in this course. Energy Storage Systems concepts are also introduced as a part of this course.

Course Objectives:
- To study the basic principles of illumination and its measurements and to design the different types lighting systems.
- To acquaint with the different types of heating and welding techniques.
- To understand the operating principles and characteristics of various motors with respect to speed, temperature and loading conditions.
- To understand the basic principles of electric traction including speed–time curves of different traction services and calculation of braking, acceleration and other related parameters.
- To Introduce the concepts of various types of energy storage systems.

UNIT – I
Illumination fundamentals
Introduction - terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter–Sources of light.
Various Illumination Methods
Discharge lamps - MV and SV lamps – Comparison between tungsten filament lamps and fluorescent tubes–Basic principles of light control– Types and design of lighting and flood lighting–LED lighting - Energy conservation.

UNIT – II
Selection of Motors
Choice of Motor - Type of Electric Drives - Starting And Running Characteristics – Speed Control–Temperature Rise – Applications of Electric Drives–Types of Industrial Loads–Continuous–Intermittent And Variable Loads–Load Equalization - Introduction To Energy Efficient Motors.

UNIT – III
Electric Heating
Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating.

Electric Welding
Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding.

UNIT – IV
Electric Traction
System of electric traction and track electrification– Review of existing electric traction systems in India–Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. Calculations of tractive effort– power – Specific energy consumption for given run–Effect of varying acceleration and braking retardation–

Adhesive weight and braking retardation adhesive weight and coefficient of adhesion-Numerical problems.

UNIT – V

Introduction to Energy Storage Systems

Need For Energy Storage - Types of Energy Storage-Thermal - Electrical - Magnetic And Chemical Storage Systems - Comparison of Energy Storage Technologies-Applications.

Course Outcomes:

After the completion of the course the student should be able to:

- Identify various illumination methods produced by different illuminating sources.
- Identify a suitable motor for electric drives and industrial applications
- Identify most appropriate heating and welding techniques for suitable applications.
- Distinguish various traction system and determine the tractive effort and specific energy consumption.
- Validate the necessity and usage of different energy storage schemes for different applications and comparisons.

Text Books:

1. Utilization of Electric Energy – by E. Openshaw Taylor - Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab - Dhanpat Rai& Sons.
3. “Thermal energy storage systems and applications”-by Ibrahim Dincer and Mark A.Rosen. John Wiley and Sons 2002.

Reference Books:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana - New Age International (P) Limited - Publishers - 1996.
2. Generation - Distribution and Utilization of electrical Energy – by C.L. Wadhwa - New Age International (P) Limited - Publishers - 1997.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3

COMPUTER ARCHITECTURE AND ORGANIZATION
(PROFESSIONAL ELECTIVE – I)

Preamble:
This course aims to give an overall idea about the architecture and working of a computer. This course covers various operations of a computers and discusses the memory organization of a digital computer. This course will be very useful to the students to improve their computer programming skills and to find job opportunities in hardware/software industry.

Course Objectives:
- To explain the basic working of a digital computer.
- To understand the register transfer language and micro operators.
- To learn various addressing modes supported by the processors.
- To be familiar with peripheral interfacing with processors.
- To understand memory hierarchy in computers.

UNIT-I
Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input- Output and Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic.

UNIT-II
Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit. Micro programmed Control: Control Memory, Address Sequencing, Micro program Example, Design of Control Unit.

UNIT-III
Central Processing Unit: Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer(RISC) Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISK Pipeline, Vector Processing, Array Processors.

UNIT-IV
Input/output Organization: Peripheral Devices, I/O interface, Asynchronous data transfer, Modes of transfer, priority Interrupt, Direct memory access, Input-Output Processor (IOP), Serial Communication.

UNIT-V
Memory Organization: Memory Hierarchy, Main memory, Auxiliary memory, Associate Memory, Cache Memory, and Virtual memory, Memory Management Hardware.

Course Outcomes:
At the end of this course, student will be able to:
- Explain the instruction cycle of a computer.
- Understand various micro operations and register transfer language.
- Describe parallel processing and pipelining.
- Interface different peripherals with processors.
- Know the advantages of cache and virtual memory.

Text Books:

1. Computer System Architecture, M. Morris Mano, Prentice Hall of India Pvt. Ltd., 3rd Edition, Sept. 2008.

References Books:

1. Computer Architecture and Organization, William Stallings, PHI Pvt. Ltd., Eastern Economy Edition, Sixth Edition, 2003.
2. Computer Organization and Architecture, Linda Null, Julia Lobur, Narosa Publications ISBN 81-7319-609-5
3. Computer System Organization by John. P. Hayes.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3

OPTIMIZATION TECHNIQUES
(PROFESSIONAL ELECTIVE – I)

Preamble:

The applications of optimization techniques have expanded in all fields including design aspects of electrical machines. It is pertinent to link these concepts with that of programming skills. This course covers basic features of linear & nonlinear programming problems. Concept of dynamic programming and transportation problem are also taught.

Course Objectives:

- To know the importance of adopting optimization techniques in day to day life.
- To analyse the importance of various types of constraints at various stages.
- To learn more on linear & nonlinear programming concepts.
- To analyse the significance of transportation problem.
- To learn the concepts of dynamic programming.

UNIT – I

Introduction to Optimization Techniques

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques

Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II

Linear Programming

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.

UNIT – III

Nonlinear Programming

Unconstrained cases - One – dimensional minimization methods: Classification - Fibonacci method and Quadratic interpolation method - Univariate method - Powell's method and steepest descent method.

Constrained cases - Characteristics of a constrained problem - Classification - Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods.

UNIT – IV

Transportation Problem

Finding initial basic feasible solution by north – west corner rule - least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems – Special cases in transportation problem.

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UNIT - V

Dynamic Programming

Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Course Outcomes:

After the completion of the course the student should be able to:

- State and formulate the optimization problem without and with constraints, also apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Formulate a mathematical model and apply non-linear programming techniques for unconstrained and constrained case studies.
- Solve transportation and assignment problem by using Linear programming Simplex method.
- Formulate and apply Dynamic programming technique to inventory control, production planning, engineering design problems etc. to reach a final optimal solution from the current optimal solution.

Text Books:

2. "Engineering optimization: Theory and practice"-by S. S.Rao- New Age International (P) Limited - 3rd edition - 1998.
1. "Introductory Operations Research" by H.S. Kasene& K.D. Kumar - Springer (India) 2013.

Reference Books:

1. "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan - New Age International (P) Limited - Publishers - 3rd edition - 1996.
3. Operations Research – by Dr. S.D.Sharma- Kedarnath - Ramnath& Co - 2012.
3. "Operations Research: An Introduction" – by H.A.Taha - PHI pvt. Ltd. - 6th edition
4. Linear Programming–by G.Hadley.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
OBJECT ORIENTED PROGRAMMING THROUGH JAVA (PROFESSIONAL ELECTIVE – I)					

Course Objective: Implementing programs for user interface and application development using core java principles

UNIT-I
Focus on object oriented concepts and java program structure and its installation, Introduction to OOP Introduction, Need of Object Oriented Programming, Principles of Object Oriented Languages, Procedural languages Vs OOP, Applications of OOP, History of JAVA, Java Virtual Machine, Java Features.

UNIT-II
Comprehension of java programming constructs, control structures in Java Programming Constructs Variables , Primitive Datatypes, Identifiers- Naming Conventions, Keywords, Literals, Operators-Binary, Unary and ternary, Expressions, Precedence rules and Associativity, Primitive Type Conversion and Casting, Flow of control Branching, Conditional, loops.,

UNIT-III
Classes and Objects- classes, Objects, Creating Objects, Methods, constructors, Constructor overloading, cleaning up unused objects-Garbage collector, Class variable and Methods-Static keyword, this keyword, Arrays, Command line arguments **Interfaces and exception handling Inheritance:** Types of Inheritance, Deriving classes using extends keyword, Method overloading, super keyword, final keyword, Abstract class Interfaces,

UNIT-IV
Understanding of Thread concepts and I/O in Java MultiThreading: java.lang.Thread, The main Thread, Creation of new threads, Thread priority, Multithreading- Using isAlive() and join(), Syncronization, suspending and Resuming threads, Communication between Threads.

UNIT-V
Being able to build dynamic user interfaces using applets and Event handling in java Swing: Introduction, javax.swing package , JFrame, JApplet, JPanel, Components in swings, Layout Managers, JList and JScroll Pane, Split Pane, JTabbedPane, Dialog Box.

Course Outcomes: By the end of the course student will be able to

- Discuss and understand java programming constructs, Control structures
- Illustrate and experiment Object Oriented Concepts like classes, objects
- Apply Object Oriented Constructs such as Inheritance, interfaces, and exception handling
- Construct applications using multithreading and I/O
- Develop Dynamic User Interfaces using applets and Event Handling in java

Text Books:

1. The Complete Refernce Java, 8ed, Herbert Schildt, TMH
4. Programming in JAVA, Sachin Malhotra, Saurabh choudhary, Oxford.

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Reference Books:

1. JAVA Programming, K.Rajkumar.Pearson
2. Core JAVA, Black Book, Nageswara Rao, Wiley, Dream Tech
3. JAVA for Beginners, 4e, Joyce Farrell, Ankit R. Bhavsar, Cengage Learning.
4. Object oriented programming with JAVA, Essentials and Applications, Raj Kumar Bhuyya, Selvi, Chu TMH
5. Introduction to Java programming, 7th ed, Y Daniel Liang, Pearson Core JAVA for Beginners, Rashmi Kanta Das, Vikas.
6. Object Oriented Programming through JAVA , P Radha Krishna , University Press

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III Year – I SEMESTER		L	T	P	C
		0	0	3	1.5
CONTROL SYSTEMS LABORATORY					

Course Objectives:

- To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors and Synchros.
- To understand time and frequency responses of control system with and without controllers and compensators.

Any 10 of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Effect of P, PD, PI, PID Controller on a second order systems
4. Design of Lag and lead compensation – Magnitude and phase plot
5. Transfer function of DC motor
6. Bode Plot, Root locus, Nyquist Plots for the transfer functions of systems up to 5^{th} order using MATLAB.
7. Controllability and Observability Test using MAT LAB.
8. Temperature controller using PID
9. Characteristics of magnetic amplifiers
10. Characteristics of AC servo motor
11. Characteristics of DC servo motor
12. To study and verify the truth table of logic gates and simple Boolean expressions using PLC.

Course Outcomes:

After the completion of the course the student should be able to:

- Analyze the performance and working Magnetic amplifier, D.C and A.C. servo motors and synchros.
- Design P,PI,PD and PID controllers
- Design lag, lead and lag–lead compensators
- Evaluate temperature control of an oven using PID controller
- Determine the transfer function of D.C Motor
- Analyze the performance of D.C and A.C Servo Motor.
- Test the controllability and observability.
- Judge the stability in time and frequency domain.
- To examine different logic gates and Boolean expressions using PLC.

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III Year –I SEMESTER		L	T	P	C
		0	0	3	1.5
POWER ELECTRONICS LABORATORY					

Course objectives:

- To learn the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
- To analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
- To understand the operation of AC voltage regulator with resistive and inductive loads.
- To understand the working of Buck converter and Boost converter.
- To understand the working of single-phase & three-phase inverters.

Any 10 of the Following Experiments are to be conducted

1. Characteristics of SCR - Power MOSFET & Power IGBT.
2. R - RC & UJT firing circuits for SCR.
3. Single -Phase semi-converter with R & RL loads.
4. Single -Phase full-converter with R & RL loads.
5. Three- Phase full-converter with R & RL loads.
6. Single-phase dual converter in circulating current & non circulating current mode of operation.
7. Single-Phase AC Voltage Regulator with R & RL Loads.
8. Single-phase step down Cycloconverter with R & RL Loads.
9. Boost converter in Continuous Conduction Mode operation.
10. Buck converter in Continuous Conduction Mode operation.
11. Single -Phase square wave bridge inverter with R & RL Loads.
12. Single - Phase PWM inverter.
13. Three-phase bridge inverter with 120^0 and 180^0 conduction mode
14. SPWM control of Three-phase bridge inverter

Course outcomes:

After the completion of the course the student should be able to:

- Analyse characteristics of various power electronic devices and design firing circuits for SCR.
- Analyse the performance of single–phase dual, three–phase full–wave bridge converters and dual converter with both resistive and inductive loads.
- Examine the operation of Single-phase AC voltage regulator and Cycloconverter with resistive and inductive loads.
- Differentiate the working and control of Buck converter and Boost converter.
- Differentiate the working & control of Square wave inverter and PWM inverter.

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III Year –I SEMESTER		L	T	P	C
		2	0	0	2

SOFT SKILL COURSE
EMPLOYABILITY SKILLS

Preamble: The aim of this course is to enhance learner's knowledge of both soft skills and IT related skills so as to develop attributes that enhances interpersonal communication, earning power and job performance.

Course objectives:

- To enhance the Numerical ability skills such as addition, subtraction, multiplication, division, calculation of percentages, average etc.
- To develop the problem solving skills on time, distance and speed calculations, to improve the basic mathematical skills on arithmetic ability.
- To analyze a candidate's ability to relate a certain given group of items and illustrate it diagrammatically.
- To develop interpersonal skills and adopt good leadership behavior for empowerment of self and others.by managing stress and time effectively.
- To prepare good resume, prepare for interviews and group discussions, and to explore desired career opportunities.

UNIT - I
Numerical ability
Number system, HCF & LCM, Average, Simplification, Problems on numbers Ratio & Proportion, Partnership, Percentages, Profit & Loss

UNIT - II
Arithmetical ability
Problems on ages, Time & Distance, Problems on boats &Steams, Problems on Trains, Time & Work, Pipes & Cistern, Chain Rule.
Allegation, Simple interest and compound interest, Races & Games of skills, Calendar and Clock.

UNIT - III
Logical ability: Permutations and Combination and Probability.
Mensuration: Geometry, Areas, Volumes,
Data interpretation: Tabulation, Bar graphs, Pie charts, line graphs

UNIT - IV
Self-Management Skills
Anger Management, Stress Management, Time Management, Six Thinking Hats, Team Building, Leadership Qualities
Etiquette
Social Etiquette, Business Etiquette, Telephone Etiquette, Dining Etiquette

UNIT - V
Job-Oriented Skills
Group Discussion, Mock Group Discussions, Resume Preparation, Interview Skills, Mock Interviews

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Course outcomes:

After the completion of the course the student should be able to:

- Follow strategies in minimizing time consumption in problem solving Apply shortcut methods to solve problems
- Confidently solve any mathematical problems and utilize these mathematical skills both in their professional as well as personal life.
- Analyze, summarize and present information in quantitative forms including table, graphs and formulas
- Understand the core competencies to succeed in professional and personal life
- Learn and demonstrate a set of practical skills such as time management, self-management, handling conflicts, team leadership, etc.

Text Books:

1. R. S. Aggarwal "Quantitative Aptitude", Revised ed., S Chand publication, 2017 ISBN:8121924987
2. Barun K. Mitra, Personality Development and Soft Skills, Oxford University Press, 2011.
3. Raman, Meenakshi & Sharma, Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2011.

Reference Books:

1. S.P. Dhanavel, English and Soft Skills, Orient Blackswan, 2010.

E-resources and other digital material:

1. https://blog.feedspot.com/aptitude_youtube_channels/
2. https://www.tutorialspoint.com/quantitative_aptitude/
3. https://www.careerbless.com/aptitude/qa/home.php
4. https://www.Indiabix.com
5. https://www.freshersworld.com

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III Year –I SEMESTER		L	T	P	C
		2	0	0	0
ENVIRONMENTAL SCIENCE					

Course Objectives:

The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due tounplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

UNIT I

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects. Role of information technology in environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT II

Natural Resources: Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT III

Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity- classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT IV

Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT V

Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act - Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness. Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Text Books:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. ManjulaRani; Pearson Education, Chennai

Reference Books:

1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, CengageLearning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New AgeInternational Publishers, 2014

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III Year –I SEMESTER		L	T	P	C
		0	0	0	1.5
Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester					

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
MICROPROCESSORS AND MICROCONTROLLERS					

Preamble:
Microprocessor and Microcontroller have become important building blocks in digital electronics design. It is important for student to understand the architecture of a microprocessor and its interfacing with various modules. 8086 microprocessor architecture, programming, and interfacing is dealt in detail in this course. Interfacing, PIC, architecture, programming in C.

Course objectives:
- To understand the organization and architecture of Microprocessor
- To understand addressing modes to access memory
- To understand 8051 micro controller architecture
- To understand the programming principles for 8086 and 8051
- To understand the interfacing of Microprocessor with I/O as well as other devices
- To understand how to develop cyber physical systems

UNIT - I
Introduction to Microprocessor Architecture
Introduction and evolution of Microprocessors – Architecture of 8086 – Memory Organization of 8086 – Register Organization of 8086– Introduction to 80286 - 80386 - 80486 and Pentium (brief description about architectural advancements only).

UNIT - II
Minimum and Maximum Mode Operations
Instruction sets of 8086 - Addressing modes – Assembler directives - General bus operation of 8086 – Minimum and Maximum mode operations of 8086 – 8086 Control signal interfacing – Read and write cycle timing diagrams.

UNIT - III
Microprocessors I/O interfacing
8255 PPI– Architecture of 8255–Modes of operation– Interfacing I/O devices to 8086 using 8255– Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing– Static memory interfacing with 8086.
Architecture and interfacing of 8251 USART – Architecture and interfacing of DMA controller (8257).

UNIT - IV
8051 Microcontroller
Overview of 8051 Microcontroller – Architecture– Memory Organization – Register set – I/O ports and Interrupts – Timers and Counters – Serial Communication – Interfacing of peripherals- Instruction set.

UNIT - V
PIC Architecture
Block diagram of basic PIC 18 micro controller – registers I/O ports – Programming in C for PIC: Data types - I/O programming - logical operations - data conversion.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of the Microprocessor capability in general and explore the evaluation of microprocessors.
- Analyse the instruction sets - addressing modes - minimum and maximum modes operations of 8086 Microprocessors
- Analyse the Microcontroller and interfacing capability
- Describe the architecture and interfacing of 8051 controller
- Know the concepts of PIC micro controller and its programming.

Text Books:

1. Ray and Burchandi - "Advanced Microprocessors and Interfacing" - Tata McGraw–Hill - 3rd edition - 2006.
2. Kenneth J Ayala - "The 8051 Microcontroller Architecture - Programming and Applications" - Thomson Publishers - 2nd Edition.
3. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18 - -Muhammad Ali Mazidi - RolindD.Mckinay - Danny causey -Pearson Publisher 21st Impression.

Reference Books:

1. Microprocessors and Interfacing - Douglas V Hall - Mc–Graw Hill - 2nd Edition.
2. R.S. Kaler - "A Text book of Microprocessors and Micro Controllers" - I.K. International Publishing House Pvt. Ltd.
3. Ajay V. Deshmukh - "Microcontrollers – Theory and Applications" - Tata McGraw–Hill Companies –2005.
4. Ajit Pal - "Microcontrollers – Principles and Applications" - PHI Learning Pvt Ltd - 2011.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRICAL MEASUREMENTS AND INSTRUMENTATION					

Preamble:
This course gives an outset on principles of operation and construction of various basic instruments for measurement of different electrical quantities. Familiarization of modern digital measurement systems were also included here.

Course Objectives:
- To understand and analyze the factors that effect the various measuring units.
- To choose the appropriate meters for measuring of voltage, current, power, power factor and energy qualities & understand the concept of standardization.
- Describe the operating principle of AC & DC bridges for measurement of resistance, inductance and capacitance.
- To understand the concept of the transducer and their effectiveness in converting from one form to the other form for the ease of calculating and measuring purposes.
- To understand the operating principles of basic building blocks of digital systems, record and display units.

UNIT - I
Analog Ammeter and Voltmeters
Classification – deflecting - control and damping torques - – PMMC - moving iron type and electrostatic instruments - Construction - Torque equation - Range extension - Errors and compensations - advantages and disadvantages. Instrument transformers: Current Transformer and Potential Transformer-construction - theory - errors-Numerical Problems.

UNIT - II
Analog Wattmeters and Power Factor Meters
Electrodynamometer type wattmeter (LPF and UPF) - Power factor meters: Dynamometer and M.I type (Single phase and Three phase) - Construction - theory - torque equation - advantages and disadvantages.
Potentiometers: Introduction to DC and AC Potentiometers – Construction-working – Applications - Numerical Problems.

UNIT - III
Measurements of Electrical parameters
DC Bridges: Method of measuring low - medium and high resistance - sensitivity of Wheat stone's bridge - Kelvin's double bridge for measuring low resistance - Loss of charge method for measurement of high resistance - Megger – measurement of earth resistance - Numerical Problems.

AC Bridges: Measurement of inductance and quality factor - - Maxwell's bridge - - Hay's bridge - - Anderson's bridge. Measurement of capacitance and loss angle - - Desauty's bridge - Schering Bridge - Wien's bridge - Wagner's earthing device - - Numerical Problems.

UNIT - IV
Transducers
Definition - Classification - Resistive - Inductive and Capacitive Transducer - LVDT - Strain Gauge - Thermistors - Thermocouples - Piezo electric and Photo Diode Transducers - Hall effect sensors- Numerical Problems.

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UNIT - V

Digital meters

Digital Voltmeters – Successive approximation DVM - Ramp type DVM and Integrating type DVM – Digital frequency meter - Digital multimeter - Digital tachometer - Digital Energy Meter - Q meter - Power Analyzer. CRO- measurement of phase difference & Frequency using lissajious patterns - Numerical Problems.

Course Outcomes:

After the completion of the course the student should be able to:

- Know the construction and working of various types of analog instruments.
- Describe the construction and working of wattmeter and power factor meters
- Know the construction and working various bridges for the measurement resistance - inductance and capacitance
- Know the operational concepts of various transducers
- Know the construction and operation digital meters

Text Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.

Reference Books:

2. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co. Publications - 19th revised edition - 2011.
3. Electrical and Electronic Measurements and instrumentation by R.K.Rajput - S.Chand - 3rd edition.
3. Electrical Measurements by Buckingham and Price - Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
POWER SYSTEM ANALYSIS					

Preamble:
The course is designed to give students the required knowledge for the design and analysis of power flow studies and faults in electrical power systems. Calculation of power flow in a power system network using various techniques, formation of Z_{bus} and its importance are covered in this course. It also deals with short circuit analysis and analysis of power system for steady state and transient stability.

Course Objectives:
- To develop the impedance diagram (p.u) and formation of Y_{bus}
- To learn the different load flow methods.
- To learn the Z_{bus} building algorithm.
- To learn short circuit calculation for symmetrical faults
- To learn the effect of unsymmetrical faults and their effects.
- To learn the stability of power systems and method to improve stability.

UNIT - I
Circuit Topology & Per Unit Representation
Graph theory definition – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y_{bus} matrix by singular transformation and direct inspection methods – Per Unit Quantities–Single line diagram – Impedance diagram of a power system – Numerical Problems.

UNIT - II
Power Flow Studies
Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) – Decoupled and Fast Decoupled methods – Algorithmic approach – Numerical Problems on 3–bus system only.

UNIT - III
Z-Bus Algorithm & Symmetrical Fault Analysis
Formation of Z_{bus}**:** Algorithm for the Modification of Z_{bus} Matrix (without mutual impedance) – Numerical Problems.
Symmetrical Fault Analysis:
Reactance's of Synchronous Machine – Three Phase Short Circuit Currents - Short circuit MVA calculations for Power Systems – Numerical Problems.

UNIT - IV
Symmetrical Components
Definition of symmetrical components – symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence impedances and Sequence networks: Synchronous generator – Transmission line and transformers – Numerical Problems.
Unsymmetrical Fault analysis
Various types of faults: LG– LL– LLG and LLL on unloaded alternator-Numerical problems.

UNIT - V
Power System Stability Analysis
Elementary concepts of Steady state – Dynamic and Transient Stabilities – Swing equation – Steady state stability – Equal area criterion of stability – Applications of Equal area criterion – Factors affecting transient stability – Methods to improve steady state and transient stability – Numerical problems.

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Course Outcomes:

After the completion of the course the student should be able to:

- Draw impedance diagram for a power system network and calculate per unit quantities.
- Apply the load flow solution to a power system using different methods.
- Form Z_{bus} for a power system networks and analyse the effect of symmetrical faults.
- Find the sequence components for power system Components and analyse its effects of unsymmetrical faults.
- Analyse the stability concepts of a power system.

Text Books:

1. Power System Analysis by Grainger and Stevenson - Tata McGraw Hill.2003
2. Modern Power system Analysis – by I.J.Nagrath & D .P.Kothari: Tata McGraw–Hill Publishing Company - 3rd edition - 2007.

Reference Books:

1. Power System Analysis – by A.R.Bergen - Prentice Hall - 2nd edition - 2009.
2. Power System Analysis by HadiSaadat – Tata McGraw–Hill 3rd edition - 2010.
3. Power System Analysis by B.R.Gupta - A H Wheeler Publishing Company Limited - 1998.
4. Power System Analysis and Design by J.Duncan Glover - M.S.Sarma - T.J.Overbye – Cengage Learning publications - 5th edition - 2011.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
SIGNALS AND SYSTEMS (PROFESSIONAL ELECTIVE – II)					

Preamble:
This course aims to lay the foundational aspects of signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, and communication theory & control systems.

Course Objectives:
- This gives the basics of signals and systems required for all electrical engineering related courses.
- To understand the behavior of signal in time and frequency domain.
- To understand the characteristics of Linear Time Invariant (LTI) systems.
- Concepts of the correlation and sampling process.
- This give concepts of signals and Systems along with its analysis using different transform techniques.

UNIT – I
Introduction
Definition of Signals and Systems - Classification of Signals - Classification of Systems - Operations on signals: time-shifting - time-scaling - amplitude-shifting - amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals - Singularity functions and related functions: impulse function - step function signum function and ramp function. Analogy between vectors and signals - orthogonal signal space - Signal approximation using orthogonal functions - Mean square error - closed or complete set of orthogonal functions - Orthogonally in complex functions. Related Problems.

UNIT – II
Fourier Series And Fourier Transform
Fourier series representation of continuous time periodic signals - properties of Fourier series - Dirichlet's conditions - Trigonometric Fourier series and Exponential Fourier series - Relation between Trigonometric and Exponential Fourier series - Complex Fourier spectrum. Deriving Fourier transform from Fourier series - Fourier transform of arbitrary signal - Fourier transform of standard signals - Fourier transform of periodic signals - properties of Fourier transforms - Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform. Related Problems.

UNIT – III
Analysis of Linear Systems
Introduction - Linear system - impulse response - Response of a linear system - Linear time invariant (LTI) system - Linear time variant (LTV) system - Concept of convolution in time domain and frequency domain - Graphical representation of convolution - Transfer function of a LTI system - Related problems. Filter characteristics of linear systems. Distortion less transmission through a system - Signal bandwidth - system bandwidth - Ideal LPF - HPF and BPF characteristics - Causality and Poly-Wiener criterion for physical realization - relationship between bandwidth and rise time.

UNIT – IV
Correlation
Auto-correlation and cross-correlation of functions - properties of correlation function - Energy density spectrum - Parseval's theorem - Power density spectrum - Relation between Convolution and correlation - Detection of periodic signals in the presence of noise by correlation - Extraction of signal from noise by filtering.

Sampling Theorem

Graphical and analytical proof for Band Limited Signals - impulse sampling - Natural and Flat top Sampling - Reconstruction of signal from its samples - effect of under sampling – Aliasing - Introduction to Band Pass sampling - Related problems.

UNIT - V

Laplace Transforms

Introduction - Concept of region of convergence (ROC) for Laplace transforms - constraints on ROC for various classes of signals - Properties of L.T's - Inverse Laplace transform - Relation between L.T's - and F.T. of a signal. Laplace transform of certain signals using waveform synthesis.

Z–Transforms

Concept of Z- Transform of a discrete sequence. Region of convergence in Z-Transform - constraints on ROC for various classes of signals - Inverse Z-transform - properties of Z-transforms. Distinction between Laplace - Fourier and Z transforms.

Course Outcomes:

After the completion of the course the student should be able to:

- Apply the knowledge of various signals and operations.
- Analyze the spectral characteristics of periodic signals using Fourier Analysis.
- Classify the systems based on their properties and determine the response of LSI system using convolution.
- Understand the process of sampling and the effects of under sampling.
- Apply Laplace and z-transforms to analyze signals and Systems (continuous & discrete).

Text Books:

1. Signals - Systems & Communications - B.P. Lathi - BS Publications - 2003.
2. Signals and Systems - A.V. Oppenheim - A.S. Willsky and S.H. Nawab - PHI - 2nd Edition- 1997
3. Signals & Systems - Simon Haykin and Van Veen - Wiley - 2nd Edition - 2007

Reference Books:

1. Principles of Linear Systems and Signals – BP Lathi - Oxford University Press - 2015
2. Signals and Systems – T K Rawat - Oxford University press - 2011.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRIC DRIVES (PROFESSIONAL ELECTIVE – II)					

Preamble:
This course is an extension of power electronics applications to electric drives. This course covers in detail the application of power electronics converters for speed control of DC & AC motor drives.

Course Objectives:
- To learn the fundamentals of electric drive and different electric braking methods.
- To analyze the operation of three phase converter controlled dc motors and four quadrant operation of dc motors using dual converters.
- To discuss the DC-DCconverter control of dc motors.
- To understand the concept of speed control of induction motor by using AC voltage controllers, voltage source inverters and slip power recovery scheme.
- To learn the speed control mechanism of synchronous motors

UNIT - I
Fundamentals of Electric Drives
Electric drive and its components– Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

UNIT - II
Controlled Converter Fed DC Motor Drives
3-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics – Dual converter fed DC motor drives -Numerical problems.

UNIT - III
DC–DC Converters Fed DC Motor Drives
Single quadrant, two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current mode of operation - Output voltage and current waveforms – Speed–torque expressions and characteristics – Closed loop operation (qualitative treatment only).

UNIT - IV
Stator and Rotor side control of 3-phase Induction motor Drive
Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop V/f control of induction motor drives (qualitative treatment only). Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics.

UNIT - V
Control of Synchronous Motor Drives
Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only)– PMSM (Basic operation only).

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Course Outcomes:

After the completion of the course the student should be able to:

- Explain the fundamentals of electric drive and different electric braking methods.
- Analyze the operation of three-phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
- Describe the DC-DC converter fed control of dc motors in various quadrants of operation
- Know the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters and differentiate the stator side control and rotor side control
- Learn the concepts of speed control of synchronous motor with different methods.

Text Books:

1. Fundamentals of Electric Drives – by G K Dubey - Narosa Publications - 2nd edition – 2002.
2. Power Semiconductor Drives - by S.B.Dewan - G.R.Slemon - A.Straughen - Wiley India - 1984.

Reference Books:

1. Electric Motors and Drives Fundamentals - Types and Apllications - by Austin Hughes and Bill Drury - Newnes.4th edition - 2013.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications - 1987.
3. Power Electronic Circuits - Devices and applications by M.H.Rashid - PHI - 3rd edition - 2009.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

ADVANCED CONTROL SYSTEMS
(PROFESSIONAL ELECTIVE – II)

Preamble:
This subject aims to study state space, design of state feedback controllers and state observers, describing function and stability analysis including controllability and observability. It also deals with modern control and optimal control systems.

Course Objectives:
- To familiarize the state space representation in controllable, observable, diagonal and Jordan canonical forms.
- Iintroduce the concept of controllability and observability tests through canonical forms and design of state feedback controller by pole placement technique and State Observer design.
- Analysis of a nonlinear system using describing function approach.
- Illustrate the Lypanov's method of stability analysis for linear and non-linear continuous time autonomous systems.
- Formulation of Euler Laugrange equation for the optimization of typical functional and solutions.

UNIT - I
State Space Analysis
State Space Representation – Canonical forms – Controllable canonical form – Observable canonical form - Jordan Canonical Form - Solution of state equation – State transition matrix.

UNIT - II
Controllability - Observability and Design of Pole Placement
Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality – Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.

UNIT - III
Nonlinear Systems
Introduction to nonlinear systems - Types of nonlinearities. Introduction to phase–plane analysis - Singular points; Describing function - basic concepts - Describing functions of non- linearities.

UNIT - IV
Stability analysis by Lyapunov Method
Stability in the sense of Lyapunov – Lyapunov's stability and Lyapunov's instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

UNIT - V
Calculus of Variations
Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints –Euler lagrangine equation.

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Course Outcomes:

After the completion of the course the student should be able to:

- Analyse different canonical forms - solution of State equation.
- Design of control system using the pole placement technique is given after introducing the concept of controllability and observability.
- Analyze nonlinear system using describing function technique and phase plane analysis.
- Examine the stability analysis using Lyapunov method.
- Illustrate the Minimization of functional using calculus of variation - state and quadratic regulator problems.

Text Books:

1. Modern Control Engineering – by K. Ogata - Prentice Hall of India - 3rd edition - 1998.
2. Automatic Control Systems by B.C. Kuo - Prentice Hall Publication.

Reference Books:

1. Modern Control System Theory – by M. Gopal - New Age International Publishers - 2nd edition - 1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal - New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal - Tata Mc Graw–Hill Companies - 1997.
4. Systems and Control by Stainslaw H. Zak - Oxford Press - 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3

SWITCHGEAR AND PROTECTION
(PROFESSIONAL ELECTIVE – II)

Preamble:
In order to supply power from generating end to receiving end several equipments are connected in to the system. In order to protect the equipments and components against various operating conditions and over voltages protective devices are required to be installed in the system. Topics specified in this subject deal with various types of protective equipments and their working principle including limitations etc.

Course Objectives:
- To provide the basic principles and operation of various types of circuit breakers.
- To know the classification, operation and application of different types of electromagnetic protective relays.
- To explain protective schemes for generator and transformers.
- To gain the knowledge of various protective schemes used for feeders and bus bars.
- To explain the principle and operation of different types of static relays.
- To understand different types of over voltages in a power system and principles of different neutral grounding methods.

UNIT–I
Circuit Breakers
Application oriented evolution of Switchgear - Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Concept of oil circuit breakers– Description and operation of Air Blast– Vacuum and SF_6 circuit breakers– Circuit Breaker ratings and specifications– Concept of Auto reclosing – Application Spectrum Numerical examples

UNIT–II
Electromagnetic Protection
Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays**:** Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**:** Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

UNIT–III
Generator Protection
Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.
Transformer Protection
Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

UNIT–IV
Feeder and Bus bar Protection & Static Relays:
Over current Protection schemes – PSM - TMS – Numerical examples – Carrier current and three zone distance relay using impedance relays.
Protection of bus bars by using Differential protection.
Static relays**:** Introduction – Classification of Static Relays – Basic Components of Static Relays.

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UNIT–V

Protection against over voltage and grounding

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters.

Grounded and ungrounded neutral systems – Effects of ungrounded neutral on system performance – Methods of neutral grounding**:** Solid–resistance–Reactance–Arcing grounds and grounding Practices.

Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate the principles of arc interruption for application to high voltage circuit breakers of air - oil - vacuum - SF_6 gas type.
- Analyse the working principle and operation of different types of electromagnetic protective relays.
- Acquire knowledge of protective schemes for generator and transformers for different fault conditions.
- Classify various types of protective schemes used for feeders and bus bar protection and Types of static relays.
- Analyse the operation of different types of over voltages protective schemes required for insulation co–ordination and types of neutral grounding.

Text Books:

1. Power System Protection and Switchgear by Badri Ram and D.N Viswakarma - Tata McGraw Hill Publications - 2nd edition - 2011.
2. Power system protection- Static Relays with microprocessor applications by T.S.Madhava Rao - Tata McGraw Hill - 2nd edition.

Reference Books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide. - PHI - 2003.
2. Art & Science of Protective Relaying – by C R Mason - Wiley Eastern Ltd.
3. Protection and SwitchGear by BhaveshBhalja - R.P. Maheshwari - Nilesh G.Chothani - Oxford University Press - 2013.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
BIG DATA ANALYTICS (PROFESSIONAL ELECTIVE – II)					

Course Objectives:

- To understand the competitive advantages of big data analytics
- To understand the big data frameworks
- To learn data analysis methods
- To learn stream computing
- To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

UNIT-I
Introduction To Big Data
Big Data, Definition, Characteristic Features, Big Data Applications, Big Data vs Traditional Data, Risks of Big Data, Structure of Big Data, Challenges of Conventional Systems, Web Data, Evolution of Analytic Scalability.

UNIT-II
Hadoop Framework
Distributed File Systems, Large-Scale File System Organization, HDFS concepts, Map Reduce Execution, Algorithms using Map Reduce, Hadoop YARN.

UNIT-III
Data Analysis
Statistical Methods**:** Regression modelling, Multivariate Analysis, Classification: SVM & Kernel Methods, Rule Mining, Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Predictive Analytics, Data analysis using R.

UNIT-IV
Mining Data Streams
Streams: Concepts, Stream Data Model and Architecture, Sampling data in a stream, Mining Data Streams and Mining Time-series data, Real Time Analytics Platform (RTAP) Applications, Case Studies, Real Time Sentiment Analysis.

UNIT-V
Big Data Frameworks
Introduction to NoSQL, Aggregate Data Models, Hbase: Data Model and Implementations, Hbase Clients, Examples, Cassandra: Data Model, Examples, Cassandra Clients, Hadoop Integration.

Course Outcomes: At the end of the course, student will be able to

- Understand how to leverage the insights from big data analytics
- Analyze data by utilizing various statistical and data mining approaches
- Perform analytics on real-time streaming data
- Understand the various NoSql alternative database models

Software Links:

1. Hadoop: http://hadoop.apache.org/
2. Hive: https://cwiki.apache.org/confluence/display/Hive/Home
3. Pig latin: http://pig.apache.org/docs/r0.7.0/tutorial.html

Text Books:

1. Big Java 4th Edition, Cay Horstmann, Wiley John Wiley & Sons, INC
2. Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'reilly
3. Hadoop in Action by Chuck Lam, MANNING Publ.

Reference Books:

1. Hadoop in Practice by Alex Holmes, MANNING Publ.
2. Hadoop MapReduce Cookbook, SrinathPerera, ThilinaGunarathne
3. Michael Berthold, David J. Hand, ―Intelligent Data Analysis‖, Springer, Second Edition, 2007.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS
(OPEN ELECTIVE – II)

Preamble:
The objective of this course is to introduce learner to batteries, its parameters, charging requirements and modelling. The course will help learner to understand the types of batteries and their charging methods, develop battery management and modelling algorithms for batteries.

Course objectives:
- Able to understand the working of different batteries for EV applications
- Able to know the fundamentals of battery charging methods and their advantages
- Able to know the different kinds of equipment in charging station
- Able to know the requirements of battery management.
- Able to know method of modelling batteries and their simulation studies.

Unit - I:
EV Batteries
Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. **Lead Acid Batteries:** Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. **Nickel-based Batteries:** Nickel cadmium, Nickel metal hydride batteries. **Sodium-Based Batteries:**
Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries.
Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery.

Unit - II:
Battery charging strategies
Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

Unit -III:
Charging Infrastructure
Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

Unit - IV:
Battery-Management-System Requirements
Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics .

Unit - V:
Battery Modelling
General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

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Course Outcomes:

After the completion of the course the student should be able to:

- Describe the construction and operation of different batteries for EV applications
- Describe charging algorithms of different batteries and balancing methods of battery packs
- Describe the different kinds of infrastructure needed in the charging stations
- Describe the requirements of battery management and their maintenance.
- Obtain the modelling of batteries and develop their simulation models.

Text Books

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk. (Unit-1)
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016. (Unit-2)

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001. (Unit-3)
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016. (Unit-4)
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002. (Unit-5)

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

FUNDAMENTALS OF UTILIZATION OF ELECTRICAL ENERGY
(OPEN ELECTIVE – II)

Preamble:

In the modern society, every engineer is using electrical energy irrespective of their branch of specialization. To provide knowledge about the various electrical energy utilization technologies to non-electrical engineering students this course is developed. In this course, a detailed description about the illumination requirements and energy storage, various techniques used for heating & welding applications, and brief description about the electric traction are presented. At the end of the course, an insight in to the important techniques of various energy storage systems is also presented.

Course Objectives:

- To study the various types of Illumination equipment, measurement of Illumination, Illumination techniques.
- To know the various technologies used for heating applications using electrical energy.
- To understand the various welding techniques and operations of welding equipment and comparison.
- To know the various systems of traction, equipment used for traction.
- To understand the importance and operation of various Energy storage systems and comparison & applications.

UNIT - I
Illumination fundamentals
Introduction - terms used in illumination–Laws of illumination–Lux meter–Sources of light.
Various Illumination Methods
Tungsten filament lamps and fluorescent lamps - Comparison –Basic principles of light control– Types and design of lighting and flood lighting–LED lighting - Energy conservation.

UNIT - II
Electric Heating
Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating.

UNIT - III
Electric Welding
Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding

UNIT - IV
Electric Traction
System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves. Calculations of tractive effort– power – Specific energy consumption for given run–Effect of varying acceleration and braking retardation– Adhesive weight and braking retardation adhesive weight and coefficient of adhesion.

UNIT - V
Introduction to Energy Storage Systems
Need for energy storage - Types of energy storage-Thermal - electrical - magnetic and chemical storage systems - Comparison of energy storage technologies-Applications.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of illumination and various illumination methods.
- Know about the resistance - induction and dielectric heating.
- Learn about the resistance and arc welding and welding equipment
- Know about the mechanisms - equipment and technology used in the electric traction.
- Differentiatethe importance of various energy storage systems

Text Books:

1. Electrical Power Systems(Generation, Transmission, Distribution, Protecection and Utilization of Electrical Energy) – Dr. S.L.Uppal and Prof. Sunil S.Rao – Khanna Publisher, 15th edition, 1987.
2. Electric Power Distribution – A S Pabla – McGrawHill.

Reference Books:

1. Generation Distribution and Utilization of Electrical Energy – C.L.Wadhwa- New Age International Publishers- revised third edition.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
INDIAN ELECTRICITY ACT (OPEN ELECTIVE – II)					

Preamble:
This course helps the students to learn the electricity policies in generation, transmission and distribution networks. To understand the licensing process, regular commission, legal and special court issues and their solving capabilities.

Course Objectives:
- To acquire knowledge on national policy, plan and joint responsibilities of state and central governments.
- To understand the licensing procedures in transmission and distribution companies.
- To learn the regulatory body rules and protocols.
- To understand the offences and penalties related issues with respect to different tribunals.
- To learn the legal related issues and their resolutions.

UNIT – I
National Electricity Policy and Plan - Generation of Electricity
Electricity Act: commencement - definitions - comments; national policy on standalone systems - non-conventional energy systems - electrification and local distribution for rural areas; joint responsibilities of state and central governments in rural electrification - requirement for setting up of generating station - hydro-electric generation - captive generation; duties of generating companies.

UNIT – II
Licensing -Transmission and Distribution Of Electricity
Licensing: powers - procedures - conditions - amendments - revocation - provisions - directions - suspension and sale; inter-state and intra-state transmission; other provisions relating to transmission; provisions with respect to distribution licenses - electricity traders - supply generally; consumer protection: standard performance.
Electrical Wiring, Estimation & Costing

UNIT – III
Tariff - CEA and Regulatory Commissions
Works of licenses - provisions relating to overhead lines; Constitution and functions of Central Electricity Authority (CEA) - directions and certain powers; Constitution - powers and functions of state and central commissions - other provisions - proceedings and powers of Appropriate commission - Grants - Fund - Accounts Audit and Report.

UNIT – IV
Appellate Tribunal - Reorganisation of Boards - Offences and Penalty
Appellate Tribunal for electricity; investigation and assessment; reorganisation of boards; Offences and penalties.

UNIT – V
Special Courts - Dispute Resolution - Other Provisions and Miscellaneous
Constitution of special courts - procedures - powers - appeal - revision; arbitration; protective clauses; miscellaneous and enactments.

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Course Outcomes:

After the completion of the course the student should be able to:

- Learn the national policy and plan and the joint responsibilities of state and central governments.
- Analyze the licensing and the provisions related to transmission and distribution of electricity.
- Remember the composition and powers of Regulatory commissions and CEA.
- Learn the functions of Appellate Tribunal for electricity.
- Know the constitution procedure and provisions in Special courts and dispute resolutions.

Text Books:

1. The Electricity Act - 2003 {Act 36 of 2003 - dt.2-6-2003 - w.e.f. 10-6-2003 vide S.O. No. 669(E) - dt. 10-6-2003] published by Commercial Law Publishers (I) Pvt. Ltd.

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III Year – II SEMESTER		L	T	P	C
		0	0	3	1.5
ELECTRICAL MEASUREMENTS AND INSRUMENTATION LABORATORY					

Course Objectives:

- To understand students how different types of meters work and their construction.
- To make the students understand how to measure resistance, inductance and capacitance by AC & DC bridges.
- To understand the testing of CT and PT.
- To Understand and the characteristics of Thermo couples, LVDT, Capacitive transducer, piezoelectric transducer.
- To understand the measurement of strain and choke coil parameters.
- To study the procedure for standardization and calibration of various methods.

Any 10 of the following experiments are to be conducted

1. Calibration of dynamometer wattmeter using phantom loading
2. Measurement of resistance using Kelvin's double Bridge and Determination of its tolerance.
3. Measurement of Capacitance using Schering Bridge.
4. Measurement of Inductance using Anderson Bridge.
5. Calibration of LPF Wattmeter by direct loading.
6. Measurement of 3 phase reactive power using single wattmeter method for a balanced load.
7. Testing of C.T. using mutual inductor – Measurement of % ratio error and phase angle of given C.T. by Null deflection method.
8. P.T. testing by comparison – V.G as Null detector – Measurement of % ratio error and phase angle of the given P.T.
9. Determination of the characteristics of a Thermocouple.
10. Determination of the characteristics of a LVDT.
11. Determination of the characteristics for a capacitive transducer.
12. Measurement of strain for a bridge strain gauge.
13. Measurement of Choke coil parameters and single phase power using three voltmeter and three ammeter methods.
14. Calibration of single phase Energy Meter.
15. Dielectric oil Test using HV Kit.
16. Calibration of DC ammeter and voltmeter using Crompton DC Potentiometer.
17. AC Potentiometer: Polar Form / Cartesian Form - Calibration of AC voltmeter - Parameters of choke.

Course Outcomes:

After the completion of the course the student should be able to:

- Know about the phantom loading.
- Learn the calibration process.
- Measure the electrical parameters voltage - current - power - energy and electrical characteristics of resistance - inductance and capacitance.
- Gain the skill knowledge of various brides and their applications.
- Learn the usage of CT's - PT's for measurement purpose.
- Know the characteristics of transducers.
- Measure the strains - frequency and phase difference.

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III Year –II SEMESTER		L	T	P	C
		0	0	3	1.5
MICRO PROCESSORS AND MICRO CONTROLLERS LAB					

Course Objectives:

- To study programming based on 8086 microprocessor and 8051 microcontroller.
- To study 8086 microprocessor based ALP using arithmetic, logical and shift operations.
- To study to interface 8086 with I/O and other devices.
- To study parallel and serial communication using 8051& PIC 18 micro controllers.

Any 10 of the following experiments are to be conducted:

8086 Microprocessor Programs:

1. Arithmetic operations – Two 16-bit numbers and multibyte addition - subtraction - multiplication and division – Signed and unsigned arithmetic operations - ASCII – Arithmetic operations.
2. Logic operations – Shift and rotate – Converting packed BCD to unpacked BCD - BCD to ASCII conversion.
3. Arrange the given array in ascending and descending order
4. Determine the factorial of a given number
5. By using string operation and Instruction prefix**:** Move block - Reverse string Sorting - Inserting - Deleting - Length of the string - String comparison.
6. Find the first and n^{th} number of 'n' natural numbers of a Fibonacci series.
7. Find the number and sum of even and odd numbers of a given array
8. Find the sum of 'n' natural numbers and squares of 'n' natural numbers
9. Arithmetic operations on 8051
10. Conversion of decimal number to hexa equivalent and hexa equivalent to decimal number
11. Find the Sum of elements in an array and also identify the largest & smallest number of a given array using 8051.

Programs on Interfacing:

12. Interfacing 8255–PPI with 8086.
13. Stepper motor control using 8253/8255.
14. Reading and Writing on a parallel port using 8051
15. Timer in different modes using 8051
16. Serial communication implementation using 8051
17. Understanding three memory areas of 00 – FF Using 8051 external interrupts.
18. Traffic Light Controller using 8051.

Course Outcomes:

After the completion of the course the student should be able to:

- Write assembly language program using 8086 microprocessor based on arithmetic - logical - number systems and shift operations.
- Write assembly language programs for numeric operations and array handling problems.
- Write a assembly program on string operations.
- Interface 8086 with I/O and other devices.
- Do parallel and serial communication using 8051 & PIC 18 micro controllers.
- Program microprocessors and microcontrollers for real world applications.

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III Year – II SEMESTER		L	T	P	C
		0	0	3	1.5
POWER SYSTEMS AND SIMULATION LAB					

Course Objectives:

To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Any of 5 experiments are to be conducted from each section:

Section I: Power Systems Lab:

1. Estimation of sequence impedances of 3-phase Transformer
2. Estimation of sequence impedances of 3-phase Alternator by Fault Analysis
3. Estimation of sequence impedances of 3-phase Alternator by Direct method
4. Estimation of ABCD parameters on transmission line model
5. Performance of long transmission line without compensation
6. Performance of long transmission line with shunt compensation
7. Analyze the Ferranti effect on long transmission line

Section II: Simulation Lab

8. Determination of Y_{bus} using direct inspection method
9. Load flow solution of a power system network using Gauss-Seidel method
10. Load flow solution of a power system network using Newton Raphson method.
11. Formation of Z_{bus} by building algorithm.
12. Economic load dispatch with & without losses
13. Load frequency control of a two area Power System without & with PI controller
14. Transient Stability analysis of single machine connected to an infinite bus (SMIB) using equal area criterion.

Course Outcomes:

After the completion of the course the student should be able to:

- Estimate the sequence impedances of 3-phase Transformer and Alternators
- Evaluate the performance of transmission lines
- Analyse and simulate power flow methods in power systems
- Analyse and simulate the performance of PI controller for load frequency control.
- Analyse and simulate stability studies of power systems

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III Year – II SEMESTER		L	T	P	C
		2	0	0	2

SKILL ADVANCED COURSE
MACHINE LEARNING WITH PYTHON

Course Objectives:
From the course the student will learn

- patterns and concepts from data without being explicitly programmed in various IOT nodes.
- to design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- to explore supervised and unsupervised learning paradigms of machine earning, Deep learning technique and various feature extraction strategies.

UNIT-I
Introduction to Machine Learning with Python
Introduction to Machine Learning, basic terminology, Types of Machine Learning and Applications, Using Python for Machine Learning: Installing Python and packages from the Python Package Index, Introduction to NumPy, SciPy, matplotlib and scikitlearn, Tiny application of Machine Learning.

UNIT-II
Supervised Learning
Types of Supervised Learning, Supervised Machine Learning Algorithms: k-Nearest Neighbors, Linear Models, Naive Bayes Classifiers, Decision Trees, Ensembles of Decision Trees, Kernelized Support Vector Machines, Uncertainty Estimates from Classifiers.

UNIT-III
Unsupervised Learning
Types of Unsupervised Learning, challenges, Preprocessing and scaling, Dimensionality Reduction, Feature Extraction, Manifold Learning, Clustering: K-Means Clustering, Agglomerative Clustering, DBSCAN, Comparing and Evaluating Clustering Algorithms.

UNIT-IV
Representing Data and Engineering Features
Categorical Variables, Binning, Discretization, Linear Models, Trees, Interactions and Polynomials, Univariate Nonlinear Transformations, Automatic Feature Selection. Parameter Selection with Preprocessing, Building Pipelines, The General Pipeline Interface.

UNIT-V
Working with Text Data (Data Visualization)
Types of Data Represented as Strings, Example Application: Sentiment Analysis of Movie Reviews, Representing Text Data as a Bag of Words, Stop Words, Rescaling the Data with tf-idf, Investigating Model Coefficients, Approaching a Machine Learning Problem, Testing Production Systems, Ranking, Recommender Systems and Other kinds of Learning.

Course Outcomes: At the end of the course, student will be able to

- Illustrate and comprehend the basics of Machine Learning with Python
- Demonstrate the algorithms of Supervised Learning and be able to differentiate linear and logistic regressions
- Demonstrate the algorithms of Unsupervised Learning and be able to understand the clustering algorithms
- Evaluate the concepts of binning, pipeline Interfaces with examples
- Apply the sentiment analysis for various case studies

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Text Books:

1. Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Muller & Sarah Guido, Orielly Publications, 2019.
2. Python Machine Learning, Sebastian Raschka & Vahid Mirjalili, 3rd Edition, 2019.
3. Building Machine Learning Systems with Python, Luis Pedro Coelho, Willi Richert, 2nd Edition, 2015.

Reference Books:

1. Machine Learning, Tom M. Mitchell, Mc Graw-Hill Publication, 2017

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III Year – II SEMESTER		L	T	P	C
		2	0	0	0
RESEARCH METHODOLOGY					

Course objectives:

- To understand the objectives and characteristics of a research problem.
- To analyze research related information and to follow research ethics
- To understand the types of intellectual property rights.
- To learn about the scope of patent rights.
- To understand the new developments in IPR.

UNIT - I

Research problem: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT - II

Literature study: Effective literature studies approaches, analysis Plagiarism, Research ethics, Technical writing: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT - III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright.
Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT - V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs.

Course Outcomes:

At the end of the course, student will be able to

- Understand objectives and characteristics of a research problem
- Analyze research related information and to follow research ethics.
- Understand the types of intellectual property rights.
- Learn about the scope of IPR.
- Understand the new developments in IPR.

Text Books:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

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References Books:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
DIGITAL SIGNAL PROCESSING (PROFESSIONAL ELECTIVE –III)					

Preamble:
The course has been designed to cater to the needs of electronic industry transforms. This course covers basic concepts of signal processing, various transformation techniques. It provides students to relies about different filter structure and also coding of speech signals.

Course Objectives:

- To explore the basic concepts of digital signal processing.
- To connect the time domain signal to frequency domain signals using fourier transform.
- To understand the basic structures of IRR systems.
- To understand and design FIR Digital filters.
- To explore the concepts of multiple sampling rates for DSP.

UNIT - I
Introduction
Introduction to Digital Signal Processing: Discrete time signals & sequences - Classification of Discrete time systems - stability of LTI systems - Invertability - Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms - solution of difference equations using Z-transforms - System function.

UNIT - II
Discrete Fourier Transforms and FFT Algorithms
Discrete Fourier Series representation of periodic sequences -Properties of Discrete Fourier Series - Discrete Fourier transforms: Properties of DFT - linear filtering methods based on DFT - Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms - Inverse FFT.

UNIT - III
Design and Realizations of IIR Digital Filters
Analog filter approximations – Butter worth and Chebyshev - Design of IIR Digital filters from analog filters - Design Examples. Analog and Digital frequency transformations.
Basic structures of IIR systems – Direct-Form Structures - Transposed Structures - Cascade-Form Structures - Parallel-Form Structures Lattice and Lattice-Ladder Structures.

UNIT - IV
Design and Realizations of FIR Digital Filters
Characteristics of FIR Filters with Linear Phase - Frequency Response of Linear Phase FIR Filters - Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique - Comparison of IIR & FIR filters.
Basic structures of FIR systems – Direct-Form Structure - Cascade-Form Structures Linear Phase Realizations - Lattice structures.

UNIT - V
Multirate Digital Signal Processing
Introduction-Decimation –Interpolation-Sampling Rate Conversion by a Rational Factor-Implementation of sampling rate converters-Applications of Multirate Signal Processing-Digital Filter Banks.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of Digital signal processing - frequency domain representation &z-transform.
- Compute discrete Fourier transform and fast fourier transforms for different sequences.
- Design IIR filters through analog filter approximation and basic structure of IIR filters.
- Design FIR filters with window techniques and basic structure of FIR filters.
- Learn the concepts of Multirate Signal Processing.

Text Books:

1. Digital Signal Processing - Principles - Algorithms - and Applications: John G. Proakis - Dimitris G.Manolakis - 4th Edition - Pearson Education / PHI - 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer - PHI.
3. Digital Signal Processing: A Computer based approach. Sanjit K Mitra - 4th Edition - TMH - 2014.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou - TATA McGraw Hill - 2006
2. Digital Signal Processing: MH Hayes - Schaum's Outlines - TATA Mc-Graw Hill - 2007.
3. DSP Primer - C. Britton Rorabaugh - Tata McGraw Hill - 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling - Sandra L.Harris - Thomson - 2007.
5. Digital Signal Processing – Alan V. Oppenheim - Ronald W. Schafer - PHI Ed. - 2006.
6. Digital Signal Processing – K Raja Rajeswari - 1st edition - I.K. International Publishing - House - 2014.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3

RENEWABLE AND DISTRIBUTED ENERGY TECHNOLOGIES
(PROFESSIONAL ELECTIVE – III)

Preamble:
To impart knowledge on various renewable sources such as solar, wind and hydel perspectives.
To know the requirements of various hybrid sources as distributed energy technologies.

Course Objectives:
- To understand the basic concepts on wind energy systems with concept on aerodynamics, horizontal and vertical axis wind turbines.
- To understand the various relations between speed, power and energy in the wind systems.
- It provides the knowledge in fundamentals of solar energy systems, various components of solar thermal systems, applications in the relevant fields and design of PV systems.
- To understand the Hydel system components and their design concepts. To get an idea on different other sources like tidal, geothermal and gas based units.
- To understand the use of various renewable sources as distributed generators.

UNIT – I
Brief idea on renewable and distributed sources - their usefulness and advantages; Wind Energy Systems: Estimates of wind energy potential - wind maps - Instrumentation for wind velocity measurements - Aerodynamic and mechanical aspects of wind machine design - Conversion to electrical energy - Aspects of location of wind farms.

UNIT – II
Wind speed and energy - Speed and power relations - Power extraction from wind - Tip speed ratio (TSR) - Functional structure of wind energy conversion systems - Pitch and speed control - Power-speed-TSR characteristics - Fixed speed and variable speed wind turbine control - Power optimization - Electrical generators - Self-Excited and Doubly-Fed Induction Generators operation and control.

UNIT – III
Solar PV Systems: Present and new technological developments in photovoltaic - estimation of solar irradiance - components of solar energy systems - solar-thermal system applications to power generation - heating - Types of PV systems - Modelling of PV cell - current-voltage and power-voltage characteristics - Effects of temperature - Solar array simulator - Sun tracking - Peak power operations - PV system - MPPT techniques - Effects of partial shading on the characteristic curves and associated MPPT techniques - Solar park design outline.

UNIT – IV
Hydel Power: Water power estimates - use of hydrographs - hydraulic turbine - characteristics and part load performance - design of wheels - draft tubes and penstocks - plant layouts; Brief idea of other sources viz. - tidal - geothermal - gas-based - etc.

UNIT - V
Requirements of hybrid/combined use of different renewable and distributed sources - Need of energy storage; Control of frequency and voltage of distributed generation in Stand-alone and Grid-connected mode - use of energy storage and power electronics interfaces for the connection to grid and loads - Design and optimization of size of renewable sources and storages.

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Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate basic concepts of renewable and distributed sources
- Demonstrate the components of wind energy conversion systems.
- Model PV systems and analyse MPPT Techniques.
- Illustrate the concept of Energy Production from Hydro - Tidal and Geothermal.
- Distinguish between standalone and grid connected DG systems and design hybrid renewable energy systems.

Text Books & Reference Books:

1. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011.
2. Loi Lei Lai and Tze Fun Chan 'Distributed Generation: Induction and Permanent Magnet Generators' - Wiley-IEEE Press - 2007.
3. Studies' Craig Anderson and Rudolf I. Howard 'Wind and Hydropower Integration: Concepts - Considerations and Case - Nova Publisher - 2012.
4. Amanda E. Niemi and Cory M. Fincher 'Hydropower from Small and Low-Head Hydro Technologies' - Nova Publisher - 2011.
6. D. Yogi Goswami - Frank Kreith and Jan F. Kreider 'Principles of Solar Engineering' - Taylor & Francis 2000.
7. G. N. Tiwari 'Solar Energy Technology' - Nova Science Publishers - 2005.
8. Math J. Bollen - Fainan Hassan 'Integration of Distributed Generation in the Power System' - IEEE Press - 2011.
9. S. Heier and R. Waddington 'Grid Intergration of Wind Energy Conversion Systems' – Wiley - 2006.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEMS (PROFESSIONAL ELECTIVE – III)					

Preamble:
Flexible Alternating Current Transmission System controllers have become a part of modern power system. It is important for the student to understand the principle of operation of series and shunt compensators by using power electronics. As the heart of many power electronic controllers is a voltage source converter (VSC), the student should be acquainted with the operation and control of VSC. The modern power electronic controllers are also introduced.

Course Objectives:
- To learn the basics of power flow control in transmission lines using FACTS controllers
- To explain operation and control of voltage source converter.
- To learn the method of shunt compensation using static VAR compensators.
- To learn the methods of compensation using series compensators
- To explain operation of Unified Power Flow Controller (UPFC) and Interline Power flow Controller (IPFC).

UNIT - I
Introduction to FACTS
Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers – Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

UNIT - II
Voltage source and Current source converters
Voltage source converter (VSC) – Single phase full-wave bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full-wave bridge converter - Transformer connections for 12 pulse operation.
Current Source Converter (CSC)-Three–phase current source converter – Comparison of current source converter with voltage source converter.

UNIT - III
Shunt Compensators
Objectives – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping.

Variable Impedance Type VAR Generator: Thyristor Switched/Controlled Reactor (TSR/TCR) – Thyristor Switched Capacitor (TSC) – Fixed Capacitor–Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor and Thyristor Controlled Reactor (TSC–TCR) - Switching Converter type VAR generator.
Principle of operation and comparison of SVC and STATCOM.

UNIT - IV
Series Compensators
Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. Variable Impedance type series compensators – GTO Thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC) - Switching Converter type Series Compensation – Static Synchronous Series Compensator.

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UNIT - V

Combined Compensators

Schematic and basic operating principles of unified power flow controller (UPFC) and Interline power flow controller (IPFC) – Controller applications of transmission lines.

Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of facts controller and power flow control in transmission line.
- Demonstrate operation and control of voltage source converter and know the concepts current source converter.
- Analyse compensation by using different compensators to improve stability and reduce power oscillations in the transmission lines.
- Know the concepts methods of compensations using series compensators.
- Analyse operation of Unified Power Flow Controller (UPFC) and Interline power flow controller (IPFC).

Text Books:

1. "Understanding FACTS" N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:— Standard Publications, 2001.

Reference Books:

1. "Flexible ac transmission system (FACTS)" Edited by Yong Hue Song and Allan T Johns, Institution of Electrical Engineers, London.
2. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R. Mohan Mathur and Rajiv K.Varma, Wiley.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3

POWER SYSTEM DEREGULATION
(PROFESSIONAL ELECTIVE – III)

Preamble:
This aim of this course is to enhance competition and bring consumers new choices and economic benefits. The electricity industry is evolving into a distributed and competitive industry in which market forces drive the price of electricity and reduce the net cost through increased competition. The process has, obviously, necessitated reformulation of established models of power system operation and control activities.

Course Objectives:
- To provide in-depth knowledge of operation of deregulated electricity market systems.
- To calculate Available Transfer Capability (ATC) using different mechanisms
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To learn importance effects and classification of congestion management methods.
- To know the information about various ancillary services and markets in national international scenario

UNIT – I
Need and conditions for deregulation. Introduction of Market structure - Market Architecture - Spot market - forward markets and settlements. Review of Concepts marginal cost of generation - least-cost operation - incremental cost of generation. Power System Operation - Power Exchange.

UNIT – II
Electricity sector structures and Ownership /management - the forms of Ownership and management. Different structure model like Monopoly model - Purchasing agency model - wholesale competition model - Retail competition model - Definition of Available Transfer Capability (ATC) - computation of ATC.

UNIT – III
Framework and methods for the analysis of Bilateral and pool markets - LMP based markets.
Auction models and price formation - price based unit commitment - country practices.

UNIT – IV
Transmission network and market power. Power wheeling transactions and marginal costing - transmission costing. Congestion management methods- market splitting - counter-trading; Effect of congestion on LMPs- country practices.

UNIT – V
Ancillary Services and System Security in Deregulation. Classifications and definitions - AS management in various markets- country practices. Technical - economic - & regulatory issues involved in the deregulation of the power industry.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the essential and operation of deregulated electricity market systems.
- Learn about the different structure model.
- Analyze various types of electricity market operational and control issues using new mathematical models.
- Analyse LMP's wheeling transactions and congestion management.
- Analyze impact of ancillary services.

Text Books:

1. Power System Economics: Designing markets for electricity - Steven Stoft - wiley publishers - 2002.
2. Operation of restructured power systems - K. Bhattacharya - M.H.J. Bollen and J.E. Daalder – Springer - 2012.

Reference Books:

1. Power generation - operation and control - -J. Wood and B. F. Wollenberg - Wiley – 1998.
2. Market operations in electric power systems - M. Shahidehpour - H. Yaminand Z. Li – Wiley - 2003.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac - Wiley - 2nd edition - 2018.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau - IEEE Press series on Power Engineering.
5. "Competition and Choice in Electricity" by Sally Hunt and Graham Shuttleworth - Wiley publishers - 1997.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
DATA BASE MANAGEMENT SYSTEMS (Professional Elective –III)					

Course Objectives:
To learn the principles of systematically designing and using large scale Database Management Systems for various applications.

UNIT-I
Overview of Database System
Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Transaction Management, Database Architecture, Data Mining and Informational Retrieval, Specialty Databases, Database Users and Administrators, History of Database Systems**. [Text Book -2]**

UNIT-II
Introduction to Database Design
Database Design and ER Diagrams, Entities, Attributes and Entity Sets, Relationships and Relationship Sets, Additional Features of the ER Model, Conceptual Design with the ER Model, Extended ER features **[Text Book -1]**

UNIT-III
Relational Model
Introduction to the Relational Model, Integrity Constraints over Relations, Enforcing Integrity Constraints, Querying Relational Data, Logical Database Design: ER to Relational, Introduction to Views, Destroying/Altering Tables and Views **[Text Book -1]**

UNIT-IV
SQL: Queries, Constraints, Triggers
The Form of a Basic SQL Query, UNION, INTERSECT and EXCEPT, Nested Queries, Aggregate Operators, Null Values, Complex Integrity Constraints in SQL, Triggers, Exceptions, Procedures, Functions **[Text Book -1]**

UNIT-V
Normal Forms
Introduction to Schema Refinement, Functional Dependencies, Reasoning about FDs, Normal Forms, Properties of Decompositions, Normalization. **[Text Book -1]**

Course Outcomes: At the end of the course, student will be able to

- Illustrate the concept of databases, database management systems, database languages, database structures and their work
- Apply ER modeling and Relational modeling for designing simple databases.
- Summarize the concepts related to relational model and SQL and Write database queries using relational algebra and structured query language.
- Design and develop databases from the real world by applying the concepts of Normalization.
- Outline the issues associated with Transaction Management and Recovery, Tree Structured Indexing

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Text Books:

1. Data base Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, Mc Graw-Hill
2. Data base System Concepts, 6/e, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Mc Graw-Hill

Reference Books:

1. Database Systems, 6/e Ramez Elmasri, Shamkant B. Navathe, Pearson
2. Introduction to Database Systems, 8/e, C J Date, Pearson
3. Database Systems, 9/e, Carlos Coronel, Steven Morris, Peter Rob, Cengage

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
HYBRID ELECTRIC VEHICLES (PROFESSIONAL ELECTIVE –IV)					

Preamble:
This course aims to study and understand merits of electric and hybrid electric vehicles. It also deals with different power electronic converters and battery storage systems for electric and hybrid electric vehicles.

Course Objectives:
- To familiarize the students with the need and advantages of electric and hybrid electric vehicles.
- To know various architectures of hybrid electric vehicles.
- To understand the power management of plug in electric vehicles.
- To study and understand different power converters used in electrical vehicles.
- To familiarize with different batteries and other storage systems.

UNIT - I
Introduction
Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.

UNIT - II
Hybridization of Automobile
Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.

UNIT - III
Special Machines for EV and HEVs
Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs. Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.

UNIT - IV
Power Electronics in HEVs
Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters - Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers.

UNIT - V
Energy Sources for HEVs
Energy Storage - Battery based energy storage and simplified models of battery - fuel cells - their characteristics and simplified models - super capacitor based energy storage - its analysis and simplified models - flywheels and their modeling for energy storage in EV/HEV - Hybridization of various energy storage devices.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concept of electric vehicles and hybrid electric vehicles.
- Familiar with different configuration of hybrid electric vehicles.
- Choose an effective motor for EV and HEV application
- Understand the power converters used in hybrid electric vehicles
- Know different batteries and other energy storage systems.

Text Books

1. Ali Emadi - Advanced Electric Drive Vehicles - CRC Press - 2014.
2. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2003.

Reference Books:

1. MehrdadEhsani - YimiGao - Sebastian E. Gay - Ali Emadi - Modern Electric - Hybrid Electric and Fuel Cell Vehicles: Fundamentals - Theory and Design - CRC Press - 2004.
2. James Larminie - John Lowry - Electric Vehicle Technology Explained - Wiley - 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co - 2007.

Research Books:

1. Pistooa G. - “Power Sources - Models - Sustanability - Infrstructure and the market” - Elsevier 2008
2. Mi Chris - Masrur A. - and Gao D.W. - “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
HIGH VOLTAGE ENGINEERING (PROFESSIONAL ELECTIVE – IV)					

Preamble:
With the growth of power, HV power transmission has become an important subject. The performance of generating equipment requires knowledge of different phenomena occurring at higher voltage. Thus evaluations of various insulating materials are required for protection of HV equipments. Keeping this in view the course is designed to understand various phenomena related to breakdown study and withstand characteristics of insulating materials. The course also describes the generation and measurement of DC, AC and Impulse voltages.

Course Objectives:
- To understand HV breakdown phenomena in gases.
- To understand the breakdown phenomenon of liquids and solid dielectrics.
- To acquaint with the generating principle of operation and design of HVDC, AC voltages.
- To understand the generating principles of Impulse voltages & currents.
- To understand various techniques for AC, DC and Impulse measurements of high voltages and currents.

UNIT - I
Break down phenomenon in Gaseous:
Insulating Materials: Types - applications and properties. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases and its limitations – Streamers Theory of break down – Paschen's law- Paschens curve.

UNIT - II
Break down phenomenon in Liquids:
Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquids.
Break down phenomenon in Solids:
Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of composite solid dielectrics.

UNIT - III
Generation of High DC voltages:
Voltage Doubler Circuit - Voltage Multiplier Circuit – Vande- Graaff Generator.
Generation of High AC voltages:
Cascaded Transformers – Resonant Transformers –Tesla Coil

UNIT - IV
Generation of Impulse voltages:
Specifications of impulse wave – Analysis of RLC circuit only- Marx Circuit.
Generation of Impulse currents:
Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping and control of impulse generators.

UNIT - V
Measurement of High DC & AC Voltages:
Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps.

Measurement of Impulse Voltages & Currents:
Potential dividers with CRO - Hall Generator - Rogowski Coils.

Course Outcomes:
After the completion of the course the student should be able to:

- Recognise the dielectric properties of gaseous materials used in HV equipment.
- Differentiate the break down phenomenon in liquid and solid dielectric materials.
- Acquaint with the techniques of generation of high AC and DC voltages
- Acquaint with the techniques of generation of high Impulse voltages and currents.
- Getting the knowledge of measurement of high AC - DC - Impulse voltages and currents.

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel by Elsevier - 2nd Edition.
2. High Voltage Engineering and Technology by Ryan - IET Publishers - 2nd edition.

Reference Books:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications - 3rd Edition.
2. High Voltage Engineering by C.L.Wadhwa - New Age Internationals (P) Limited – 1997.
3. High Voltage Insulation Engineering by RavindraArora - Wolfgang Mosch - New Age International (P) Limited - 1995.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS (PROFESSIONAL ELECTIVE –IV)					

Preamble:
Technological advances in recent years have resulted in the development of the programmable logic controllers (PLCS) and a consequence resolution of control engineering. This course is an introduction topic and aims to ease the tasks of students coming first into constant in the PLCs. It addresses the different nomenclature and programs forms with examples**.**

Course Objectives:
- To understand the various components of PLC systems and ladder diagrams.
- To know the programming instructions and registers in the PLC.
- To understand the use and applications of timer and counter functions.
- To familiar the data handling function and this application.
- To understand and implementation of analog operations and PID modules.

UNIT – I
Introduction to PLC systems
I/O modules and interfacing - CPU processor - programming Equipment - programming formats - construction of PLC ladder diagrams - Devices connected to I/O Modules. Digital logic gates - programming in the Boolean algebra system - conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings - ladder diagram construction and flowchart for spray process system.

UNIT – II
PLC Programming: Input instructions - outputs - operational procedures - programming examples using contacts and coils. Drill press operation.
PLC Registers: Characteristics of Registers - module addressing - holding registers - Input Registers - Output Registers.

UNIT – III
PLC Functions: Timer functions & Industrial applications - counters - counter function industrial applications - Arithmetic functions - Number comparison functions - number conversion functions.

UNIT – IV
Data Handling functions: SKIP - Master control Relay - Jump - Move - FIFO - FAL - ONS - CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register - sequence functions and applications - controlling of two-axis & three axis Robots with PLC - Matrix functions.

UNIT – V
Analog PLC operation: Analog modules & systems - Analog signal processing - Multi bit Data Processing - Analog output Application Examples - PID principles - position indicator with PID control - PID Modules - PID tuning - PID functions.

Course Outcomes:
After the completion of the course the student should be able to:
- Illustrate I/O modules of PLC systems and ladder diagrams
- Demonstrate various types registers and programming instructions.
- Examine various types of PLC functions and its applications.
- Assess different data handling functions and its applications.
- Describe the analog operations and PID modules.

Text books:

1. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss - Fifth Edition - PHI
2. Programmable Logic Controllers- Programming Method and Applications –JR.Hackworth &F.D Hackworth Jr. –Pearson - 2004

Reference Books:

1. Introduction to Programmable Logic Controllers- Gary A. Dunning - 3rd edition - Cengage Learning - 2005.
2. Programmable Logic Controllers –W.Bolton - 5th Edition - Elsevier publisher - 2009.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
CLOUD COMPUTING WITH AWS (PROFESSIONAL ELECTIVE –IV)					

Course Objectives:

This course is intended to analyze the basics of cloud computing, and make aware students with diversified technologies working for cloud architecture. Course will be focusing on architecture, service models, privacy & security in cloud.

UNIT-I

Introduction of Cloud Computing: What is Cloud Computing, How it works, Types of Cloud, Goals & Challenges, Leveraging Cloud Computing, Cloud Economics and Total Cost of Ownership

UNIT-II

Cloud Service Models Software as a Service (SaaS): Introduction, Challenges in SaaS Model, SaaS Integration Services, Advantages and Disadvantages. Infrastructure As a Services (IaaS): Introduction, Virtual Machines, VM Migration Services, Advantages and Disadvantages. Platform As a service (PaaS): Introduction, Integration of Private and Public Cloud, Advantages and Disadvantages.

UNIT-III

Virtualization and Abstraction: What is Virtualization and how abstraction is provided in cloud? Advantages and Disadvantages, Types of Hypervisor, and Load balancing.

UNIT-IV

Amazon Web Services Getting started with AWS, AWS Compute, Storage, and Networking, AWS Security, Identity, and Access Management, AWS Database Options, AWS Elasticity and Management Tools

UNIT-V

Architecting on AWS Introduction to System Design: AWS Essentials Review and System Design for High Availability, Automation and Serverless Architectures: Event-Driven Scaling, Well-Architected Best Practices: Security, Reliability, Performance Efficiency, Cost Optimization and Deployment and Implementation: Design Patterns and Sample Architectures

Course Outcomes:

Upon completion of this course, the students will be able to

- Understand and analyze the architecture of Cloud (Analyze).
- Identify and apply deployment and management options of AWS Cloud Architecture (Apply).
- Design architectures to decouple infrastructure and reduce interdependencies (Create).

Text books:

1. Judith Hurwitz, R Bloor, M.Kanfman, F.Halper “Cloud Computing for Dummies”, Wiley India Edition, First Edition
2. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, ”Cloud Computing: Principles and Paradigms”, Wiley Publication, 2011

Reference Books:

1. Tim Mather, SubraKumara swamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'ReillyMedia Inc, 2009
2. Mickey Iqbal 2010, " IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach", MC Press
3. Frank H. P. Fitzek, Marcos D. Katz, "Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks", Wiley Publications, ISBN: 978-0-470- 97389-9, Jan 2014.

e-Books:

1. https://www.manning.com/books/exploring-cloud-computing (Paid Version)

Supplementary Resources:

1. NPTEL online course : https://onlinecourses.nptel.ac.in/noc17_cs23/preview
2. MOOC : https://www.edx.org/micromasters/cloud-computing
3. Coursera: https://www.coursera.org/specializations/cloud-computing
4. AWS Academy: AWS Cloud Computing Architecture at https://aws.amazon.com/training/awsacademy/cloud-computing-architecture/

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3

DEEP LEARNING TECHNIQUES
(PROFESSIONAL ELECTIVE –IV)

Course Objectives: At the end of the course, the students will be expected to:

- Learn deep learning methods for working with sequential data,
- Learn deep recurrent and memory networks,
- Learn deep Turing machines,
- Apply such deep learning mechanisms to various learning problems.
- Know the open issues in deep learning, and have a grasp of the current research directions.

UNIT-I
Fundamentals of Deep Learning
Artificial Intelligence, History of Machine learning: Probabilistic Modeling, Early Neural Networks, Kernel Methods, Decision Trees, Random forests and Gradient Boosting Machines, **Fundamentals of Machine Learning:** Four Branches of Machine Learning, Evaluating Machine learning Models, Overfitting and Underfitting. **[Text Book 2]**

UNIT-II
Introducing Deep Learning
Biological and Machine Vision, Human and Machine Language, Artificial Neural Networks, Training Deep Networks, Improving Deep Networks. **[Text Book3]**

UNIT-III
Neural Networks
Anatomy of Neural Network, Introduction to Keras: Keras, TensorFlow, Theano and CNTK, Setting up Deep Learning Workstation, Classifying Movie Reviews: Binary Classification, Classifying newswires: Multiclass Classification. **[Text Book 2]**

UNIT-IV
Convolutional Neural Networks
Nerual Network and Representation Learing, Convolutional Layers, Multichannel Convolution Operation, **Recurrent Neural Networks:** Introduction to RNN, RNN Code, PyTorch Tensors: Deep Learning with PyTorch, CNN in PyTorch. **[Text Book 3]**

UNIT-V
Interactive Applications of Deep Learning
Machine Vision, Natural Language processing, Generative Adversial Networks, Deep Reinforcement Learning. **[Text Book 1]**
Deep Learning Research: Autoencoders**,** Deep Generative Models: Boltzmann Machines Restricted Boltzmann Machines, Deep Belief Networks. **[Text Book 1]**

Course Outcomes: After the completion of the course, student will be able to

- Demonstrate the fundamental concepts learning techniques of Artificial Intelligence, Machine Learning and Deep Learning.
- Discuss the Neural Network training, various random models**.**
- Explain the Techniques of Keras, TensorFlow, Theano and CNTK
- Classify the Concepts of CNN and RNN
- Implement Interactive Applications of Deep Learning.

Text Books:

1. Deep Learning- Ian Goodfellow, Yoshua Bengio and Aaron Courvile, MIT Press, 2016
2. Deep Learning with Python - Francois Chollet, Released December 2017, Publisher(s): Manning Publications, ISBN: 9781617294433
3. Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence - Jon Krohn, Grant Beyleveld, Aglaé Bassens, Released September 2019, Publisher(s): Addison-Wesley Professional, ISBN: 9780135116821
4. Deep Learning from Scratch - Seth Weidman, Released September 2019, Publisher(s): O'Reilly Media, Inc., ISBN: 9781492041412

Reference Books:

1. Artificial Neural Networks, Yegnanarayana, B., PHI Learning Pvt. Ltd, 2009.
2. Matrix Computations, Golub, G.,H., and Van Loan,C.,F, JHU Press,2013.
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education, 2004.

Web Link:

1. Swayam NPTEL: Deep Learning: https://onlinecourses.nptel.ac.in/noc22_cs22/preview

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
POWER SYSTEM OPERATION AND CONTROL (PROFESSIONAL ELECTIVE –V)					

Preamble:
This subject deals with economic operation of Power Systems, Hydrothermal scheduling and modeling of turbines, generators and automatic controllers. It emphasizes on single area and two area load frequency control and reactive power control.

Course Objectives:
- To understand optimal dispatch of generation with and without losses.
- To understand the optimal scheduling of hydro thermal systems.
- To understand the optimal unit commitment problem.
- To understand the load frequency control for single area system with and without controllers
- To understand the load frequency control for two area system with and without controllers
- To understand the reactive power control and compensation of transmission lines.

UNIT - I
Economic Operation of Power Systems
Optimal operation of Generators in Thermal power stations - – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

UNIT - II
Hydrothermal Scheduling
Mathematical Formulation – Solution Technique.
Unit Commitment
Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming.

UNIT – III
Load Frequency Control-I
Modelling of steam turbine – Generator – Mathematical modelling of speed governing system – Transfer function – Necessity of keeping frequency constant. Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

UNIT - IV
Load Frequency Control-II
Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case – Tie-line bias control – Load Frequency Control and Economic dispatch control.

UNIT - V
Compensation in Power Systems
Overview of Reactive Power control – Reactive Power compensation in transmission systems – Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – compensated transmission lines. Introduction of FACTS devices – Need of FACTS controllers – Types of FACTS devices.

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Course Outcomes:

After the completion of the course the student should be able to:

- Compute optimal load scheduling of Generators.
- Formulate hydrothermal scheduling and unit commitment problem..
- Analyse effect of Load Frequency Control for single area systems
- Analyse effect of Load Frequency Control for two area systems
- Describe the effect of reactive power control for transmission lines.

Text Books:

1. Power Generation - Operation and Control by Allen J Wood - Bruce F WollenBerg 3rd Edition - Wiley Publication 2014.
2. Electric Energy systems Theory – by O.I.Elgerd - Tata McGraw–hill Publishing Company Ltd. - Second edition.
3. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata McGraw Hill Publishing Company Ltd - 2nd edition.

Reference Books:

1. Power System Analysis and Stability by S.S.Vadhera - Khanna Publications - 4th edition - 2005.
2. Power System Analysis by Grainger and Stevenson - Tata McGraw Hill.
3. Power System Analysis by HadiSaadat – – Tata McGraw–Hill 3rd edition - 2010.
4. Power System stability & control - Prabha Kundur - TMH - 1994.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
SWITCHED MODE POWER CONVERSION (PROFESSIONAL ELECTIVE –V)					

Preamble:
This course is highly relevant to students who are interested in analysis, design and control of switch mode converters.

Course Objectives:
- To illustrate CCM and DCM modes of operation of non-isolated switched mode converters.
- To illustrate the working of isolated switched mode converters.
- To analyze ZVS and ZCS operation of buck, boost converters.
- To learn about the control schemes & design aspects of transformers, inductors and capacitors.
- To model the converters and design controller for closed loop operation of switched mode converters.

UNIT – I
Non-Isolated Switch Mode Converters
Control of DC-DC converters: Buck converters - Boost converters - Buck-Boost converter - CUK Converter - continuous and discontinuous operation - Converter realization with non-ideal components.

UNIT – II
Isolated Switched Mode Converters
Forwarded converter - flyback converter - push-pull converter - half-bridge converter - full bridge converter.

UNIT – III
Resonant Converters
Basic resonant circuit concepts - series resonant circuits - parallel resonant circuits - zero current switching quasi-resonant buck converter - zero current switching quasi-resonant boost converter - zero voltage switching quasi-resonant buck converter - zero voltage switching quasi-resonant boost converter.

UNIT – IV
Control Schemes of Converters and Magnetic Design
Voltage mode control - Current mode control - Current control mode instability.
Magnetic Design: Transformer design - inductor and capacitor design.

UNIT – V
Modelling of Converters and Controller Design Based on Linearization:
Formulation of large signal models for buck and boost converters using state space analysis-derivation of averaged large signal model using circuit averaging method-small signal model derivation- average switch modelling technique to obtain small signal models of buck and boost converters- Transfer function of converters-Controller design based on linearization.

Course Outcomes:
After the completion of the course the student should be able to:
- Design and analyse the operation of non-isolated switch mode converters.
- Analyze the operation of isolated switch mode converters.
- Illustrate the operation of resonant converters.
- Analyse the control schemes of converters and design transformer and inductor.
- Model the converters and design controller for closed loop operation.

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Text Books:

1. Fundamentals of Power Electronics- Erickson - Robert W. - Maksimovic - Dragan - Springer - 2011.
2. Power switching converters- Simon Ang - Alejandro Oliva - CRC Press - 2010.
3. Power Electronics: Essentials & Applications- L. Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992.

Reference Books:

1. Switching Power Supply Design- Abraham I. Pressman - McGraw-Hill Ryerson - Limited - 1991.
2. Power Electronics: converters Applications & Design – Mohan - Undeland - Robbins-Wiley publications.
3. Design of Magnetic Components for Switched Mode Power Converters- Z Umanand - S.P. Bhat - John Wiley & Sons Australia - 1992.
4. Elements of Power Electronics – Philip T. Krein - Oxford University press - 2014.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3

AI APPLICATIONS TO ELECTRICAL ENGINEERING
(PROFESSIONAL ELECTIVE – V)

Preamble:
This course introduces the basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks. Also deals with Associate Memories and introduces Fuzzy sets and Fuzzy Logic system components. The Neural Network and Fuzzy Network system application to Electrical Engineering is also presented. This subject is very important and useful for doing Project Work.

Course Objectives:
- To understand artificial neuron models & learning methods of ANN.
- To utilize different algorithms of ANN.
- To distinguish between classical and fuzzy sets.
- To illustrated different modules of fuzzy controller.
- To analyze applications of neural networks and fuzzy logic.

UNIT – I
Introduction
Artificial Neural Networks (ANN) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised - unsupervised and reinforced) – Neural networks learning rules. Single layer feed forward neural networks: concept of pattern and its types - perceptron training and classification using Discrete and Continuous perceptron algorithms– linear separability- XOR function.

UNIT – II
Multi-layer feed forward networks
Generalized delta rule– Back Propagation algorithm– Radial Basis Function (RBF) network - Kohonen's self-organizing feature maps (KSOFM) - Learning Vector Quantization (LVQ) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

UNIT – III
Classical Sets and Fuzzy Sets
Introduction to classical sets- properties - Operations and relations - Fuzzy sets - Operations - Properties - Fuzzy relations - Cardinalities - Membership functions.

UNIT – IV
Fuzzy Logic Modules
Fuzzification - Membership value assignment - development of rule base and decision making system - Defuzzification to crisp sets - Defuzzification methods.

UNIT – V
Applications
Neural network applications: Load flow studies - load forecasting - reactive power control.
Fuzzy logic applications: Economic load dispatch - speed control of DC motors - single area and two area load frequency control.

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Course Outcomes:

After the completion of the course the student should be able to:

- Analyse different models of artificial neuron & Use learning methods of ANN.
- Evaluate different paradigms of ANN.
- Classify between classical and fuzzy sets.
- Illustrate different modules of Fuzzy logic controller.
- Apply Neural Networks and fuzzy logic for real-time applications.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda - Jaico Publishing House - 1997.
2. Neural Networks - Fuzzy logic - Genetic algorithms: synthesis and applications by Rajasekharanand Pai – PHI Publication.

Reference Books:

1. Artificial Neural Network – B.Yegnanarayana - PHI - 2012.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc - 1997.
3. Introduction to Neural Networks using MATLAB 6.0 – S N Sivanandam - SSumathi - S N Deepa TMGH
4. Introduction to Fuzzy Logic using MATLAB – S N Sivanandam - SSumathi - S N Deepa Springer - 2007.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
DATA SCIENCE **(PROFESSIONAL ELECTIVE –V)**					

Course Objectives:
From the course the student will learn

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce Python code to statistically analyze a dataset;
- Critically evaluate data visualizations based on their design and use for communicating stories from data

UNIT-I
Introduction to Core Concepts and Technologies
Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

UNIT-II
Data Collection and Management
Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

UNIT-III
Data Analysis
Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

UNIT-IV:
Data Visualization
Introduction, Types of data visualization, Data for visualization- Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

UNIT-V
Applications of Data Science
Technologies for visualization, Bokeh (Python), recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Course Outcomes:
By the end of the course, student will be able to

- Acquire the knowledge and expertise to become a proficient data scientist
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science
- Explain how data is collected, managed and stored for data science
- Interpret the key concepts in data science, including their real-world applications and the toolkit used by data scientists
- Illustrate data collection and management scripts using MongoDB

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Text Books:

1. "The Art of Data Science", 1st edition, Roger D. Peng and Elizabeth matsui, Lean Publications, 2015
2. "Algorithms for Data Science", 1st edition, Steele, Brian, Chandler, John, Reddy, Swarna, springers Publications, 2016

Reference Books:

1. Doing Data Science: Straight Talk From The Frontline, 1st edition, Cathy O'Neil and Rachel Schutt, O'Reilly, 2013
2. Mining of Massive Datasets, 2nd edition, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, v2.1, Cambridge University Press, 2014

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
MEAN STACK TECHNOLOGIES **(PROFESSIONAL ELECTIVE –V)**					

Course Objectives:

- To Learn the basics of Web Designing using HTML, DHTML, and CSS
- To learn the basics about Client side scripts and Server side scripts

UNIT I
HTML & DHTML
Introduction, HTML Formatting, Hyper-Links, Lists, Tables, Images, Forms, Frames, Cascading Style sheets, Types, XML, Document type definition, XML Schemas, Document Object model, HTML and Scripting Access, Rollover Buttons, Moving objects with DHTML, Ramifications of DHTML.

UNIT II
Introduction to Client Side scripting
JavaScript, Control statements, Functions, Arrays, Objects, Events, Dynamic HTML with Java Script, AJAX: Ajax Client Server Architecture, XML Http Request Object, Call Back Methods.

UNIT III
Web Application
Web servers, IIS (XAMPP, LAMPP) and Tomcat Servers, Server Side Scripting, Java Servlets, Java Server Pages, Java Server Faces, JSF Components, Session Tracking, Cookies.

UNIT- IV: PHP Programming
Basic Syntax, Defining variable and constant, PHP Data types, Operator and Expression, Operator Precedence, Decisions and Loop, Functions & Recursion, String Processing and Regular Expressions, Form Processing, Working with file and Directories, Cookies.

UNIT- V
JDBC
Database Connectivity with MySQL, Servlets, JSP, PHP, MongoDB, NOSQL Database, Fundamentals of JQuery and Bootstrap.
Case Studies - Student information system, Health Management System

Course Outcomes: At the end of the course, student will be able to

- Describe basics of Web Designing using HTML, DHTML, and CSS
- Build real world applications using client side and server side scripting languages
- Design and develop applications using web servers
- Analyze the basics of PHP programming
- Apply Database connectivity with case study for student Information System and Health Management system

Text Books:

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, “Internet & World Wide Web How to Program”, Fifth Edition, Deitel Series, 2012.
2. Jason Gilmore, “Beginning PHP and MySQL from Novice to Professional”, Fourth Edition, Apress Publications, 2010.

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Reference Books:

1. Brown, Ethan, "Web Development with Node and Express: Leveraging the JavaScript Stack", O'Reilly Media, 2019. CSE Dept. Flexible Curriculum NITTUGCSE19 95.
2. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, "Fullstack React: The Complete Guide to React JS and Friends", Fullstack.io, 2017.
3. Kozlowski, Pawel, "Mastering Web Application Development with Angular JS", Packt Publishing Ltd., 2013.
4. Robert W. Sebesta, "Programming with World Wide Web", Fourth Edition, Pearson, 2008.
5. David William Barron, "The World of Scripting Languages", Wiley Publications, 2000.
6. Dayley B., "Node.js, MongoDB, and AngularJS Web Development", Addison-Wesley Professional, 2014.
7. Vainikka J., "Full-Stack Web Development using Django REST Framework and React", 2018

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

IV Year – I SEMESTER		L	T	P	C
		3	0	0	3

CONCEPTS OF MICROPROCESSORS AND MICROCONTROLLERS
(OPEN ELECTIVE –III)

Preamble:
Microprocessor and Microcontroller have become important building blocks in digital electronics design. It is important for student to understand the architecture of a microprocessor and its interfacing with various modules. 8086 microprocessor architecture, programming, and interfacing is dealt in detail in this course. Interfacing, PIC, architecture, programming in C.

Course objectives:
- To understand the organization and architecture of Microprocessor.
- To understand addressing modes to access memory.
- To understand the interfacing of Microprocessor with I/O as well as other devices
- To understand 8051 micro controller architecture
- To understand interfacing of 8051 and their applications.

UNIT – I
Introduction to Microprocessor Architecture
Introduction and evolution of Microprocessors – Architecture of 8086 – Memory Organization of 8086 – Register Organization of 8086– Introduction to 80286 - 80386 - 80486 and Pentium (brief description about architectural advancements only).

UNIT – II
Minimum and Maximum Mode Operations
Instruction sets of 8086 - Addressing modes – Assembler directives - General bus operation of 8086 – Minimum and Maximum mode operations of 8086 – 8086 Control signal interfacing – Read and write cycle timing diagrams.

UNIT – III
Microprocessors I/O Interfacing
8255 PPI– Architecture of 8255–Modes of operation – Interfacing I/O devices to 8086 using 8255 – Interfacing A to D converters – Interfacing D to A converters – Stepper motor interfacing– Static memory interfacing with 8086.

UNIT – IV
8051 Microcontroller
Overview of 8051 Microcontroller – Architecture – Signal description – Register set – Memory and I/O addressing.

UNIT - V
8051 Interfacing and Applications
Instruction set – I/O ports and Interrupts – Timers and Counters – Serial Communication – Interfacing of peripherals – Applications of microcontrollers.

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of the Microprocessor capability in general and explore the evaluation of microprocessors.
- Analyse the instruction sets - addressing modes - minimum and maximum modes operations of 8086 Microprocessors
- Analyse the Microcontroller and interfacing capability.
- Describe the architecture and interfacing of 8051 controller.
- Know the concepts of PIC micro controller and its programming.

Text Books:

1. Ray and Burchandi - "Advanced Microprocessors and Interfacing" - Tata McGraw–Hill - 3rd edition - 2006.
2. Kenneth J Ayala - "The 8051 Microcontroller Architecture - Programming and Applications" - Thomson Publishers - 2nd Edition.

Reference Books:

1. Microprocessors and Interfacing - Douglas V Hall - Mc–Graw Hill - 2nd Edition.
2. R.S. Kaler - "A Text book of Microprocessors and Micro Controllers" - I.K. International Publishing House Pvt. Ltd.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF ELECTRIC VEHICLES (OPEN ELECTIVE-III)					

Preamble:
This course aims to study and understand merits of electric and hybrid electric vehicles. It also deals with different power electronic converters and battery storage systems for electric and hybrid electric vehicles.

Course Objectives:
- To familiarize the students with the need and advantages of electric and hybrid electric vehicles.
- To understand various power converters used in electric vehicles.
- To know various architecture of hybrid electric vehicles.
- To be familiar all the different types of motors suitable for electric vehicles.
- To have knowledge on latest developments in strategies and other storage systems.

UNIT – I
Introduction
Fundamentals of vehicles - Components of conventional vehicles - drawbacks of conventional vehicles – Need for electric vehicles - History of Electric Vehicles – Types of Electric Vehicles – Advantages and applications of Electric Vehicles.

UNIT – II
Components of Electric Vehicles
Main components of Electric Vehicles – Power Converters - Controller and Electric Traction Motor – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.

UNIT – III
Hybrid Electric Vehicles
Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs - Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples - Merits and Demerits.

UNIT – IV
Motors for Electric Vehicles
Characteristics of traction drive - requirements of electric machines for EVs – Different motors suitable for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only)

UNIT – V
Energy Sources for Electric Vehicles
Batteries - Types of Batteries – Lithium-ion - Nickel-metal hydride - Lead-acid – Comparison of Batteries - Battery Management System – Ultra capacitors – Flywheels – Fuel Cell – it's working.

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Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate different types of electric vehicles.
- Select suitable power converters for EV applications.
- Design HEV configuration for a specific application.
- Choose an effective method for EV and HEV applications.
- Analyse a battery management system for EV and HEV.

Text Books

1. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2. Denton - Tom. Electric and hybrid vehicles. Routledge - 2020.

Reference Books:

1. Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2. Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.
4. NPTEL \ SWAYAM.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
CONCEPTS OF INTERNET OF THINGS (OPEN ELECTIVE-III)					

Course Objectives:
From the course the student will learn
- the application areas of IOT
- the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- building blocks of Internet of Things and characteristics

UNIT–I
The Internet of Things-
An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, Examples OF IoTs, Design Principles For Connected Devices, Internet connectivity, **Application Layer Protocols-** HTTP, HTTPS, FTP

UNIT–II
Business Models for Business Processes in the Internet of Things, IoT/M2M systems LAYERS AND designs standardizations, Modified OSI Stack for the IoT/M2M Systems ,ETSI M2M domains and High-level capabilities, Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.

UNIT-III
Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices.

UNIT-IV
Data Acquiring, Organizing and Analytics in IoT/M2M, Applications/Services/Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.

UNIT-V
Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.

Course Outcomes:
By the end of the course, student will be able to
- Review Internet of Things (IoT).
- Demonstrate various business models relevant to IoT.
- Construct designs for web connectivity
- Organize sources of data acquisition related to IoT, integrate to enterprise systems.
- Describe IoT with Cloud technologies.

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Text Books:

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education
2. Internet of Things, A.Bahgya and V.Madisetti, Univesity Press, 2015

Reference Books:

1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley
2. Getting Started with the Internet of Things, CunoPfister , Oreilly

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3

CONCEPTS OF POWER SYSTEM ENGINEERING
(OPEN ELECTIVE-IV)

Preamble:
This course introduces the basic concepts and knowledge regarding the power system engineering. The Course is giving the concepts of power generation, power transmission and distribution. It also covers protection, economics and power factor improvement concepts. This subject is very much useful to gain knowledge in the power systems.

Course Objectives:
- To understand the types of electric power plants and their working principles.
- To understand the concepts of electric power transmission and distribution.
- To gain the knowledge of protection and grounding of power system components.
- To know the economic aspects of electrical energy.
- To learn the importance of power factor improvement and voltage control.

UNIT - I
Power Generation Concepts & Types
Generation and sources of Energy – working principle and Schematic diagram approach of Thermal Power Plant – Hydro Power Plant - Nuclear Power Plant – Gas Power Plants – Comparison between Power Plants.

UNIT - II
Transmission and Distribution Concepts
Types of Conductors Materials – Constants of Transmission Line – Classification of Overhead Transmission Lines – Performance of Short Transmission Lines – Simple Problems.
Basic concept of Sub Station – Distribution Systems – Connection Schemes of Distribution Systems – Structure of Cables – Differences between Overhead & Underground systems.

UNIT - III
Protection and Grounding
List of Faults – Basic concepts of fuse – Circuit Breakers – Relays – SF_6 Circuit Breakers – Vacuum Circuit Breakers – Operation of Lightning Arrester – Grounding and its advantages - Methods of Neutral Grounding: Resistance - Reactance and Resonant Grounding – Numerical Problems.

UNIT - IV
Economic Aspects
Definitions of Load - Load & Load Duration Curves - Load Factor - Demand Factor – Utilization Factor – Types of Tariff - Cost of Electrical Energy – Expression for Cost of Electrical Energy – Numerical Problems

UNIT - V
Power Factor Improvement and Voltage Control
Power Factor – Effects and Causes of low Power Factor- Shunt & Series Capacitor Compensation - Numerical Problems – Need of Voltage Control – Types of Voltage regulating Devices.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of power generation by various types of power plants.
- Learn about transmission line concepts and distribution systems schemes.
- Learn about protection equipments and grounding methods of power system.
- Know the economic aspects of electrical energy and their importance.
- Know the importance of power factor improvement and voltage control in power systems.

Text Books:

1. Principles of Power System by V.K.Mehata - Rohit Mehata - S.Chand Publishers.

Reference Books:

1. Electrical Power Systems by C.L.Wadwa - New Age International Publishers.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3

CONCEPTS OF SMART GRID TECHNOLOGIES
(OPEN ELECTIVE-IV)

Preamble:
To impart the student to have an basic information of latest technologies on electrical power system scenario.

Course Objectives:
- To understand the basic concepts of smart grid.
- To understand various smart grid technologies and its usage in smart applications.
- To realize substation automation with intelligent sensors and have an idea on battery energy storage systems.
- To have basic knowledge on micro grids and DG's.
- To have an idea on communication technologies used in smart grid.

UNIT – I
Introduction to Smart Grid
Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.

UNIT – II
Smart Grid Technologies: Part 1
Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading(AMR) - Outage Management System(OMS) - Plug in Hybrid Electric Vehicles(PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers - Net Metering.

UNIT – III
Smart Grid Technologies: Part 2
Smart Substations - Substation Automation - Feeder Automation. Geographic Information System(GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection.

Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES)

UNIT – IV
Micro grids and Distributed Energy Resources
Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.

UNIT - V
Information and Communication Technology for Smart Grid
Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

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Course Outcomes:

After the completion of the course the student should be able to:

- Know the concepts of smart grids and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Know the concepts of smart substations - feeder automation - Battery Energy storage systems etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W.Gellings - Fairmont Press - 2009.
3. 3. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.
4. Smart Grids by Jean-Claude Sabonnadière - NouredineHadjsaïd - Wiley publishers – 2013.
5. Smart Power: Climate Changes - the Smart Grid - and the Future of Electric Utilities - by Peter S. Fox Penner - Island Press; 1st edition - 8 Jun 2010
6. Microgrids and Active Distribution Networks by S. Chowdhury - S. P. Chowdhury - P.Crossley - Institution of Engineering and Technology - 30 Jun 2009

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Control and Automation of Electric Power Distribution Systems (Power Engineering) by James Northcote - Green - Robert G. Wilson - CRC Press - 2017.
3. Substation Automation (Power Electronics and Power Systems) by Mladen Kezunovic - Mark G. Adamiak - Alexander P. Apostolov - Jeffrey George Gilbert - Springer - 2010.
4. Electrical Power System Quality by R. C. Dugan - Mark F. McGranghan - Surya Santoso - H. Wayne Beaty - McGraw Hill Publication - 2nd Edition.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
UNIVERSAL HUMAN VALUES-2: UNDERSTANDING HARMONY					

Course objective: To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, to understand (or developing clarity) of the harmony in the human being, family, society and nature/existence, to strengthen self-reflection and to develop the commitment and courage to act.

UNIT-1:
Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1) Purpose and motivation for the course, recapitulation from Universal Human Values-I
2) Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3) Continuous Happiness and Prosperity- A look at basic Human Aspirations
4) Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5) Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6) Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT- 2:
Understanding Harmony in the Human Being - Harmony in Myself!

1) Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2) Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3) Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4) Understanding the characteristics and activities of 'I' and harmony in 'I'
5) Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6) Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

UNIT-3:
Understanding Harmony in the Family and Society- Harmony in Human Relationship

1) Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2) Understanding the meaning of Trust; Difference between intention and competence
3) Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4) Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5) Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

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UNIT-4:

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1) Understanding the harmony in the Nature
2) Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self regulation in nature
3) Understanding Existence as Co-existence of mutually interacting units in allpervasive space
4) Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT-5:

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1) Natural acceptance of human values
2) Definitiveness of Ethical Human Conduct
3) Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4) Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5) Case studies of typical holistic technologies, management models and production systems
6) Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7) Include practice: Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

TEXT BOOKS:

1) Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1) Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2) Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3) The Story of Stuff (Book).
4) The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5) Small is Beautiful - E. F Schumacher.
6) Slow is Beautiful - Cecile Andrews.
7) Economy of Permanence - J C Kumarappa .
8) Bharat Mein Angreji Raj - PanditSunderlal .
9) Rediscovering India - by Dharampal .
10) Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
11) India Wins Freedom - Maulana Abdul Kalam Azad.
12) Vivekananda - Romain Rolland (English).
13) Gandhi - Romain Rolland (English).

Course outcome: Students will be able to discuss a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, to explain (or developing clarity) of the harmony in the human being, family, society and nature/existence, to strengthen self-reflection and to judge the commitment and courage to act.

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IV Year –I SEMESTER		L	T	P	C
		0	0	4	2
SKILL ADVANCED COURSE **MACHINE LEARNING WITH PYTHON LAB**					

Course Objectives:
This course will enable students to learn and understand different Data sets in implementing the machine learning algorithms.

Requirements: Develop the following program using Anaconda/ Jupiter/ Spider and evaluate ML models.

Experiment-1:
Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

Experiment-2:
For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

Experiment-3:
Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Experiment-4:
Exercises to solve the real-world problems using the following machine learning methods: a) Linear Regression b) Logistic Regression c) Binary Classifier

Experiment-5: Develop a program for Bias, Variance, Remove duplicates , Cross Validation
Experiment-6: Write a program to implement Categorical Encoding, One-hot Encoding

Experiment-7:
Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

Experiment-8:
Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions.

Experiment-9: Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

Experiment-10:
Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.

Experiment-11: Apply EM algorithm to cluster a Heart Disease Data Set. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Experiment-12: Exploratory Data Analysis for Classification using Pandas or Matplotlib.

Experiment-13:
Write a Python program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set

Experiment-14:
Write a program to Implement Support Vector Machines and Principle Component Analysis

Experiment-15:
Write a program to Implement Principle Component Analysis

Course Outcomes (Cos): At the end of the course, student will be able to

- Implement procedures for the machine learning algorithms
- Design and Develop Python programs for various Learning algorithms
- Apply appropriate data sets to the Machine Learning algorithms
- Develop Machine Learning algorithms to solve real world problems

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IV Year –I SEMESTER		L	T	P	C
		0	0	0	3
INDUSTRIAL / RESEARCH INTERNSHIP 2 MONTHS (MANDATORY) AFTER THIRD YEAR (TO BE EVALUATED DURING VII SEMESTER)					

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IV Year –II SEMESTER		L	T	P	C
		-	-	-	12
PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY (6 MONTHS)					

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
COMMUNICATION SYSTEMS **(Honors Engineering Course)**					

Preamble:
Awareness on the concepts and working of communication blocks is inevitable for an electrical engineering student to excel in smart grid applications.

Course Objectives:
- To develop a fundamental understanding on communication systems with emphasis on analog and digital modulation techniques.
- To get introduced to the basics of error control coding techniques.

Unit – I:
Basic blocks of Communication System
Analog Modulation - Principles of Amplitude Modulation, DSBSC, SSB-SC and VSB-SC, AM transmitters and receivers.

Unit- II
Angle Modulation - Frequency and Phase Modulation
Transmission Bandwidth of FM signals, Methods of generation and detection, FM Transmitters and Receivers.

Unit–III
Sampling theorem - Pulse Modulation Techniques
PAM, PWM and PPM concepts - PCM system – Data transmission using analog carriers (BASK, BFSK, BPSK, QPSK).

UNIT -IV
Error control coding techniques
Linear block codes- Encoder and decoder, Cyclic codes – Encoder, Syndrome Calculator, Convolution codes.

UNIT -V
Modern Communication Systems
Microwave communication systems, Optical communication system, Satellite communication system, Mobile communication system.

Course Outcomes:
After the completion of the course the student should be able to:
- Understand the basics of communication system, analog and digital modulation techniques.
- Apply the knowledge of digital electronics and understand the error control coding techniques.
- Summarize different types of communication systems and its requirements.

Text Books:
1. Simon Haykins, ‘Communication Systems’, John Wiley, 3rd Edition, 1995.
2. D.Roddy & J.Coolen, ‘Electronic Communications’, Prentice Hall of India, 4th Edition, 1999.
3. Kennedy G, ‘Electronic Communication System’, McGraw Hill, 1987.

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Reference Books:

1. Shulin Daniel, 'Error Control Coding', Pearson, 2nd Edition, 2011.
2. B.P. Lathi and Zhi Ding, 'Modern Digital and Analog Communication Systems', OUP USA Publications, 4th Edition, 2009.

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3

ELECTRICAL WIRING, ESTIMATION AND COSTING
(Honors Engineering Course)

Preamble:
This course covers the topics on simple electrical connections design considerations of electrical installations and study of different types of electrical installations. It also covers the components of substations and various motor control circuits.

Course Objectives:
- Introduce the electrical symbols and simple electrical circuits
- Able to learn the design of electrical installations.
- Able to learn the design of electrical installation for different types of buildings and small industries.
- Learn the basic components of electrical substations.
- Familiarize with the motor control circuits

UNIT - I
Electrical Symbols and Simple Electrical Circuits
Identification of electrical symbols - Electrical wiring Diagrams - Methods of representation of wiring diagrams - introduction to simple light and fan circuits - system of connection of appliances and accessories.

UNIT - II
Design Considerations of Electrical Installations
Electric supply system - Three-phase four wire distribution system - protection of electric installation against overload - short circuit and earth fault - earthing - neutral and earth wire - types of loads - systems of wiring - permissible of voltage drops and sizes of wires - estimating and costing of electrical installations.

UNIT - III
Electrical Installation for Different Types of Buildings and Small Industries
Electrical installations for electrical buildings - estimating and costing of material - simple examples on electrical installation for residential buildings - electrical installations for commercial buildings - electrical installation for small industries-case study.

UNIT - IV
Substations
Introduction - types of substations - outdoor substations-pole mounted type - indoor substations-floor mounted type - simple examples on quantity estimation-case study.

UNIT - V
Motor control circuits
Introduction to AC motors - starting of three phase squirrel cage induction motors - starting of wound rotor motors - starting of synchronous motors - contractor control circuit components - basic control circuits - motor protection.

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Course Outcomes:

After the completion of the course the student should be able to:

- Demonstrate the various electrical apparatus and their interconnections.
- Examine various components of electrical installations.
- Estimate the cost for installation of wiring for different types of building and small industries.
- Illustrate the components of electrical substations.
- Design suitable control circuit for starting of three phase induction motor and synchronous motor.

Text Books:

1. Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers - 2007.

References Books:

1. Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers - 6th edition - 1987.
2. A course in electrical installation estimating and costing – J.B.Gupta –Kataria SK & Sons - 2013.

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II Year –II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRICAL DISTRIBUTION SYSTEMS **(Honors Engineering Course)**					

Preamble:
This subject deals with the general concept of distribution system, substations and feeders as well as discusses distribution system analysis, protection and coordination, voltage control and power factor improvement.

Course Objectives
- To learn different factors of distribution system.
- To learn and design aspects of the substations and distribution systems.
- To learn the concepts of voltage drop and power loss.
- To learn the distribution system protection and its coordination.
- To learn the effect of compensation for power factor improvement.
- To learn the effect of voltage control on distribution system.

UNIT - I
General Concepts
Introduction to distribution systems - Distribution system losses – Coincidence factor – Contribution factor – loss factor – Relationship between the load factor and loss factor – Numerical Problems – Load Modeling and Characteristics – Classification and characteristics of loads (Residential - commercial - Agricultural and Industrial).

UNIT - II
Substations
Selection for location of substations - Rating of distribution substation – Service area with 'n' primary feeders – K- Factors - Benefits and methods of optimal location of substations.
Distribution Feeders
Design Considerations of distribution feeders**:** Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT - III
System Analysis
Voltage drop and power – loss calculations**:** Derivation for voltage drop and power loss in lines – Uniformly distributed loads and non-uniformly distributed loads – Three phase balanced primary lines – and Non three phase balanced primary lines.

UNIT - IV
Protection
Objectives of distribution system protection –Time current characteristics – Protective devices**:** Principle of operation of fuses – Circuit reclosures – Line sectionaliser and circuit breakers - Earth leakage circuit breakers – Protection schemes of parallel & Ring-main feeders.
Coordination of protective devices
General coordination procedure –Various types of co-ordinated operation of protective devices - Residual Current Circuit Breaker.

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UNIT - V

Compensation for Power Factor Improvement

Capacitive compensation for power factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location.

Voltage Control

Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR – Line drop compensation.

Course Outcomes:

After the completion of the course the student should be able to:

- Discriminate various factors of distribution system - load modelling and characteristic of loads.
- Know the concept of design considerations of substation and feeders.
- Determine the voltage drop and power loss for different types of distribution loads.
- Analyse the protection and its coordination for distribution systems.
- Analyse the effect of compensation for p.f improvement and voltage improvement.

Text Book:

1. "Electric Power Distribution system - Engineering" – by Turan Gonen - McGraw–hill - 2nd edition - 2008.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo - CRC press - 2nd edition.
2. Electric Power Distribution – by A.S. Pabla - Tata McGraw–hill Publishing Company - 4th edition - 1997.
3. Electrical Power Distribution Systems by V.Kamaraju - Right Publishers.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
ADVANCED COMPUTER NETWORKS **(Honors Engineering Course)**					

Preamble:
This course aim to provide a board coverage of new advanced topics in the fields of computer networks such as wireless networks, mobile networks, VPN networks, transport layer and application layers protocols.

Course Objectives:
- To know the various networks layers and protocols.
- To represents the IPv6 Addressing and Transition from IPv4 to IPv6 protocols.
- To discuss unicast and multicasting routing protocols.
- To know the different transport layer protocols-UDP, TCP & SCTP services.
- To understand the application layer protocols like WWW, HTTP, FTP etc.

UNIT – I
Network Layer and Protocols
IP Addressing: Address Space – Notations – Addressing – Networking – Network Address Translation (NAT).
Internet Protocol (IP): Datagram Format – Fragmentation – Options.
ICMPv4: Messages – Debugging Tools – ICMP Checksum.
Mobile IP: Addressing – Agents – Three Phases – Inefficiency in Mobile IP.
Virtual Private Network: VPN Technology.

UNIT – II
Next Generation IP
IPv6 Addressing: Representation – Address space – Allocation – Auto configuration – Renumbering.
Transition from IPv4 to IPv6: Dual Stack – Tunneling – Header Translation.
IPv6 Protocol: Packet Format – Extension Header.

UNIT – III
Unicast and Multicast Routing Protocols
Introduction: Inter-domain – Intra-domain Routing**.**
Routing Algorithms: Distance Vector Routing – Bellman-Ford Algorithm – Link State Routing – Path Vector Routing.
Unicast Routing Protocols: Internet Structure – Routing Information Protocol (RIP) – Open Shortest Path First (OSPF) – Border Gateway Protocol Version 4 (BGP4).
Introduction: Unicast – Multicast and Broadcast.
Intradomain Multicast Protocols: Multicast Distance Vector (DVMRP) – Multicast Link State (MOSPF) – Protocol Independent Multicast (PIM).

UNIT – IV
Transport Layer Protocols
User Datagram Protocol: User Datagram – UDP Services – UDP Applications.
Transmission Control Protocol: TCP Services – TCP features – Segment – A TCP Connection – State Transition Diagram – Windows in TCP – Flow Control – Error Control – TCP Congestion Control – TCP Timers – Options.
SCTP: SCTP Services – SCTP Features – Packet Format – An SCTP Association – Flow Control – Error Control.

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UNIT – V

Application Layer Protocols

World Wide Web and HTTP **– File Transfer:** FTP and TFTP **– Electronic mail:** Architecture – Web-Based Mail – Email Security – SMTP – POP – IMAP and MIME – SNMP. **DNS:** Concept of Domain name space – DNS operation. **DHCP:** Static and Dynamic Allocation – DHCP operation. **Remote Login:** TELNET and SSH.

Course Outcomes:

After the completion of the course the student should be able to:

- Implement various networks layers protocols.
- Configure TPV6 protocol.
- Apply the concepts of unicast and multicast routing protocol.
- Configure the transport layers protocols like UDP, TCP, SCTP Services.
- Determine application layer services working with the client server para diagrams like WWW, HTTP, FTP, e-mail, SNMP, DHCP.

Text Book:

1. "Data Communication and Networking" by Forouzan Behrouz.A, McGraw Hill Education, New Delhi, 2005.
2. "Internetworking with TCP/IP, Volume-I", 4th Edition by Comer Douglas E., Prentice Hall of India Private Limited, New Delhi, 2014.
3. "Computer Networks, 4th Edition" by Tanenbaum Andrew .S, PHI Learning, New Delhi, 2014.
4. "Advanced Computer Network" by B.M. Harwani and DT Editorial services, Dreamtech New Delhi, 2014.
5. "Computer Networks-Principles, Technologies and Protocols for Network Design" by Natalia Olifer, Victor Olifer, Wiley Publishers.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
POWER QUALITY **(Honors Engineering Course)**					

Preamble:
Power quality is a major problem for utilities and customers. Customers using sensitive critical loads need quality power for proper operation of the electrical equipment. It is important for the student to learn the power quality issues and improvement measures provided by the utility companies. This course covers the topics on voltage and current imperfections, harmonics, voltage regulation, power factor improvement, distributed generation, power quality monitoring and measurement equipment.

Course Objectives:
- To learn different types of power quality phenomena.
- To identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
- To describe power quality terms and know the power quality standards.
- To learn the principle of voltage regulation and power factor improvement methods.
- To explain the relationship between distributed generation and power quality.
- To understand the power quality monitoring concepts and the usage of measuring instruments.

UNIT - I
Introduction - Terms & Definitions
Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.

UNIT - II
Transient Over Voltages
Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.

UNIT - III
Long – Duration Voltage Variations
Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker

UNIT - IV
Harmonic distortion and solutions
Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.

UNIT - V
Distributed Generation and Monitoring
Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Monitoring
Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.

Course Outcomes:
After the completion of the course the student should be able to:

- Differentiate between different types of power quality problems.
- Explain the sources of voltage sag - voltage swell - interruptions - transients - long duration over voltages and harmonics in a power system.
- Explain the principle of voltage regulation and improvement methods.
- Analyse voltage distortion and current distortion and their indices.
- Know the concepts of distributed generation technologies and power quality monitoring.

Textbooks:

1. Electrical Power Systems Quality - Dugan R C - McGranaghan M F - Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley india publications - 2011.
3. Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

1. Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
2. Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
3. Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula - Van Nostrad Reinhold - New York.
4. Power Quality C.Shankaran - CRC Press - 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs - Mohammad A.S.Masoum–Elsevier.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III Year – I SEMESTER		L	T	P	C
		3	0	0	3

SPECIAL ELECTRICAL MACHINES
(Honors Engineering Course)

Preamble:
This is an advanced course on electrical machines. Students will be exposed to various special machines which are gaining importance in industry. This course covers topics related to principles, performance and applications of these special machines including switched reluctance motors, stepper motors, permanent magnet dc motors and linear motors.

Course Objective:
- To explain operation and control of switched reluctance motor.
- To understand the performance and control of stepper motors, and their applications.
- To describe the operation and characteristics of permanent magnet dc motor.
- To distinguish between brush dc motor and brush less dc motor**.**
- To explain the theory of travelling magnetic field and applications of linear motors.

UNIT - I
Permanent Magnet Materials and PMDC motors
Introduction - classification of permanent magnet materials used in electrical machines - minor hysteresis loop and recoil line - Stator frames of conventional dc machines - Development of electronically commutated dc motor from conventional dc motor – Permanent magnet materials and characteristics - B-H loop and demagnetization characteristics-high temperature effects-reversible losses - Irreversible losses - Mechanical properties - handling and magnetization - Application of permanent magnets in motors - power density - operating temperature range - severity of operation duty- Hysteresis - Eddy current Motors.

UNIT - II
Stepper Motors
Principle of operation of Stepper Motor – Constructional details - Classification of stepper motors – Different configuration for switching the phase windings - Control circuits for stepper motors – Open loop and closed loop control of two phase hybrid stepping motor.

UNIT - III
Switched Reluctance Motors
Construction and Principle of operation of Switched Reluctance Motor – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs.
Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.

UNIT - IV
Permanent Magnet Brushless DC Motor
Principle of operation of BLDC motor - Types of constructions - Surface mounted and interior type permanent magnet DC Motors - Torque and EMF equations for Square wave & Sine wave for PMBLDC Motor – Torque - Speed characteristics of Square wave & Sine wave for PMBLDC Motor - Merits & demerits of Square wave & Sine wave for PMBLDC Motor - Performance and efficiency – Applications.

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UNIT - V

Linear Induction Motors (LIM)

Construction– principle of operation – Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one sided LIM with back iron - equivalent circuit of LIM.

Course Outcomes:

After the completion of the course the student should be able to:

- Learn merits of PMDC motor
- Choose best control scheme for stepper motor
- Construct the various converter circuits for Switched Reluctance Motors.
- Analyse the characteristics of Brushless dc Motor.
- Understand the operation of Linear Induction Motors.

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.Venkata Ratnam, University press, 2009, New Delhi.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

DIGITAL CONTROL SYSTEMS
(Honors Engineering Course)

Preamble:
In recent years digital controllers have become popular due to their capability of accurately performing complex computations at high speeds and versatility in leading nonlinear control systems. In this context, this course focuses on the analysis and design of digital control systems.

Course objectives:
- To understand the concepts of digital control systems and assemble various components associated with it. Advantages compared to the analog type.
- The theory of z–transformations and application for the mathematical analysis of digital control systems.
- To represent the discrete–time systems in state–space model and evaluation of state transition matrix, the design of state feedback control by "the pole placement method.", design of state observers.
- To examine the stability of the system using different tests and study the conventional method of analyzing digital control systems in the w–plane.
- Design of state feedback controller through pole placement.

UNIT - I
Introduction to Signal Processing
Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Continuous and Discrete Time Signals – Sample and hold devices – Sampling theorem and data reconstruction – Frequency domain characteristics of zero order hold.

UNIT - II
Z–Transformations
Z–Transforms – Theorems – Finding inverse Z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses.

UNIT - III
State Space Analysis and the Concepts of Controllability and Observability
State space representation of discrete time systems – Solving Discrete Time state space equations – State transition matrix and its properties – Discretization of continuous time state equations – Concepts of controllability and observability – Tests(without proof).

UNIT - IV
Stability Analysis
Mapping between the S–Plane and the Z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test.
Design of Discrete–Time Control Systems By Conventional Methods
Transient and steady state specifications – Design using frequency response in the w–plane for lag and lead compensators – Root locus technique in the z–plane.

UNIT - V
State Feedback Controllers and State Observers
Design of state feedback controller through pole placement – Necessary and sufficient conditions – Ackerman's formula – Design of state observers (Full Order and Reduced Order).

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Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate advantages of digital systems, sampling and data reconstruction.
- Calculate Z Transform and Inverse Z Transfer function, pulse transfer functions of open and closed loop response.
- Construct various canonical forms and concepts of controllability and observability.
- Compute the absolute and relative stability of discrete time systems using Routh Stability criterion and Root Locus, Design lag and lead compensators to improve system performance using bode diagrams.
- Design of state feedback controllers and state observers.

Text Book:

1. Discrete–Time Control systems – K. Ogata - Pearson Education/PHI - 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal - TMH - 4th Edition.

Reference Books:

1. Digital Control Systems - Kuo - Oxford University Press - 2nd Edition - 2003.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

ANALYSIS OF POWER ELECTRONIC CONVERTERS
(Honors Engineering Course)

Preamble:
The usage of power electronics in day to day life has increased in recent years. It is important for students to analyze the power electronic converters in detail. This course covers characteristics of semiconductor devices and operation of AC-DC converters, PWM inverters & multilevel inverters.

Course Objectives:
- To learn the characteristics of switching devices & functionality of gate drive circuits.
- To illustrate the working of AC-DC converters.
- To learn functionality of PWM inverters in controlling the voltage and mitigating the harmonics.
- To understand the basic concepts of multi-level inverters.
- To learn PWM control of CHB and diode clamped multi-level inverters.

UNIT – I
Overview of Switching Devices
Power MOSFET, IGBT, GTO -static and dynamic characteristics, gate drive circuits for switching devices.

UNIT – II
AC-DC Converters
Single-phase fully-controlled converters with RL load– Continuous and Discontinuous load current operation-Evaluation of input power factor and harmonic factor Power factor improvements using extinction angle control, symmetrical angle control, PWM control. Three-Phase AC-DC fully-controlled Converters with RL load- Continuous and Discontinuous load current operation-Evaluation of input power factor and harmonic factor -three-phase dual converters.

UNIT – III
PWM Inverters
Operation of single-phase inverters -Voltage control of single-phase inverters - phase displacement Control –Bipolar PWM – Unipolar PWM- staircase PWM. Voltage Control of Three-Phase Inverters-Sinusoidal PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-Three phase current source inverters-Variable dc link inverter.

UNIT – IV
Multilevel Inverters
Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter-Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded H-bridge Multilevel Inverter, Principle of Operation, Features of Cascaded H-bridge Inverter- Comparisons of Multilevel inverters.

UNIT – V
PWM Multilevel Inverters
CHB Multilevel Inverter: SHE PWM- Phase shifted PWM-Level shifted PWM- Diode clamped Multilevel inverter: SHE PWM-Sinusoidal PWM- Space vector PWM-Capacitor voltage balancing.

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Course Outcomes:

After the completion of the course the student should be able to:

- Describe and analyze the characteristics of Switching devices
- Demonstrate the operation and perform harmonic analysis of AC-DC power converters.
- Analyze the operation of single-phase and three-phase inverters with PWM control.
- Illustrate the principles of operation of multilevel inverters.
- PWM Control of CHB and diode clamped multilevel inverters.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008.
3. HIGH-POWER CONVERTERS AND AC DRIVES – Bin Wu, Wiley-IEEE Press, 2006.

Reference Books:

1. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
2. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.
3. Power Electronics Daniel W. Hart - McGraw-Hill, 2011.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

HVDC TRANSMISSION
(Honors Engineering Course)

Preamble:
With the increasing power generation in the country and long distance power transmission, it is necessary that power should be transmitted at extra and ultra high voltage. The topics dealt in this subject relate to analysis of HVDC converters, control of HVDC converters and their protection.

Course Objectives:
- To analyse the operation of HVDC converters.
- To learn the principles of HVDC system control.
- To learn about converters faults and protection schemes of HVDC systems.
- To understand the requirements of reactive power control and filtering technique in HVDC system.
- To learn about MTDC systems and DC circuit breakers.

UNIT - I
DC Power Transmission Technology
Introduction - Historical Development - Comparison of AC and DC transmission - types of DC links - Existing HVDC Projects in INDIA. Modern Trends in HVDC Technology.

Analysis of HVDC Converters
Three Phase 6-Pulse bridge converter - simplified analysis - waveform with and without overlap - Current and voltage relationship - Equivalent circuits of converters - Analysis of a 12 pulse converters.

UNIT - II
HVDC System Control
Principles of DC link control - converter control characteristics - constant current and constant extinction angle control - constant ignition angle control - starting and stopping of HVDC link - power control & power reversal in HVDC link.

UNIT - III
Converter Faults and Protection
Over voltages in converter station - Surge arrestors - Protection against over voltages and over currents. Converter faults - Protection against faults in voltage source converter-Smoothing Reactor - Transient over voltages for DC line – Protection of DC lines.

UNIT - IV
Reactive Power Control
Sources of reactive power - Static VAR system – SVC and STATCOM - Reactive power control during transients.

Harmonics & Filters
Generation of harmonics – Types and design of various AC filters - DC filters – Active Filters.

UNIT - V
Multi Terminal HVDC Systems & DC Circuit Breakers
Types of MTDC systems - Control and Protection of MTDC system – HVDC insulation – DC line insulators – DC breakers – Characteristics and types of DC breakers.

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Course Outcomes:

After the completion of the course the student should be able to:

- Learn the basic concepts of HVDC Transmission & their converters.
- Understand the HVDC System Control Strategies with respect to protection.
- Understand the concepts of HVDC systems protection.
- Understand the various sources of reactive power
- Understand the Multi Terminal HVDC Systems.

Text Book

1. K. R. Padiyar - "HVDC Power Transmission Systems Technology and System Interactions" - New Age International (p) Limited - New Delhi - 2003.
2. Edward Wilson Kimbark - "Direct current Transmission" - Wiley Interscience - Vol. I - New York - 1971.

Reference Books

1. Vijay K. Sood - "HVDC and FACTS Controller: Application of Static Converters in power systems" - IEEE Power Electronics and Power Systems series - Kluwer Academic publishers - Boston - First edition January 2004.
2. C. Adamson and N.G. Hingorani - "High voltage DC power Transmission" - Garraway Limited - England - 1960.
3. Mohan - Undeland and Robbins - "Power Electronics Converters - Applications and Design - John Wiley & Son - Inc. - 2003.
4. J. Arrialga - "HVDC Transmission" - Peter Peregrinus Ltd. - London - 1983.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
EHVAC TRANSMISSION **(Honors Engineering Course)**					

Preamble:
This course gives the essence in the basic concepts of extra high voltage AC transmission. It also emphasis on the behavior of the line parameters for extra high voltages. The voltage gradients of the transmission line conductors gradients, the effect of corona, electrostatic field calculation, travelling wave theory concept, voltage control when the lines carriers extra high voltages and also to minimize power quality issues by using reactive power compensation.

Course Objectives:
- To calculate the transmission line parameters.
- To calculate the field effects on EHV and UHV AC lines.
- To have knowledge of corona, RI and audible noise in EHV and UHV lines.
- To have knowledge of voltage control in EHV and UHV transmission systems.
- To have knowledge of various reactive power compensating systems in EHV lines.

UNIT – I:
E.H.V. A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation. capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

UNIT – II:
Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

UNIT – III:
Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

UNIT – IV:
Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

UNIT – V:
Reactive power compensating systems: Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system, Introduction to STATCOM.

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Course Outcomes:
After the completion of the course the student should be able to:

- Calculate the transmission line parameters.
- Calculate the field effects on EHV and UHV AC lines.
- Determine the corona, RI and audible noise in EHV and UHV lines.
- Analyze voltage control and compensation problems in EHV and UHV transmission systems.
- Understand reactive power compensation using SVC and TCR

Text Books:

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
SMART GRID TECHNOLOGIES **(Honors Engineering Course)**					

Preamble:
The make radical transformation with the need to decarbonize electricity supply and to replace ageing assets to harness new information for better power system reliability and efficient.

Course Objectives:
- To understand concept of smart grid and their basic developments.
- To understand smart grid technologies and its usage in applications of introduction to smart grid technologies for electric vehicles.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy resources.
- To deal power quality aspects in smart grid with information and communication technology.

UNIT - I
Introduction to Smart Grid
Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT - II
Smart Grid Technologies: Part 1
Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading(AMR) - Outage Management System(OMS) - Plug in Hybrid Electric Vehicles(PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers - Net Metering.

UNIT - III
Smart Grid Technologies: Part 2
Smart Substations - Substation Automation - Feeder Automation. Geographic Information System (GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection.
Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES) - Wide Area Measurement System (WAMS) - Phase Measurement Unit (PMU).

UNIT - IV
Micro grids and Distributed Energy Resources
Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.

UNIT - V
Power Quality Management in Smart Grid
Power Quality & EMC in Smart Grid - Power Quality issues of Grid connected Renewable Energy Sources - Power Quality Conditioners for Smart Grid - Web based Power Quality monitoring - Introduction to Power Quality Audit.

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Information and Communication Technology for Smart Grid
Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

Course Outcomes:
After the completion of the course the student should be able to:

- Know the concept of smart grid and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Know the concepts of smart substations - feeder automation - Battery Energy storage systems etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W. Gellings - Fairmont Press - 2009.
3. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.
4. Smart Grids by Jean-Claude Sabonnadière - NouredineHadjsaïd - Wiley publishers - 2013.
5. Smart Power: Climate Changes - the Smart Grid - and the Future of Electric Utilities - by Peter S. Fox Penner - Island Press; 1st edition - 8 Jun 2010
6. Microgrids and Active Distribution Networks by S. Chowdhury - S. P. Chowdhury - P.Crossley - Institution of Engineering and Technology - 30 Jun 2009
7. Smart Grids (Power Engineering)by Stuart Borlase CRC Press.

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Control and Automation of Electric Power Distribution Systems (Power Engineering) by James Northcote - Green - Robert G. Wilson - CRC Press - 2017.
3. Substation Automation (Power Electronics and Power Systems) by MladenKezunovic - Mark G. Adamiak - Alexander P. Apostolov - Jeffrey George Gilbert - Springer - 2010.
4. Electrical Power System Quality by R. C. Dugan - Mark F. McGranghan - Surya Santoso - H. Wayne Beaty - McGraw Hill Publication - 2nd Edition.
5. Communication and Networking in Smart Grids by Yang Xiao - CRC Press - 2012.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
POWER ELECTRONIC CONTROL OF ELECTRIC DRIVES **(Honors Engineering Course)**					

Preamble:
This course covers in detail advanced speed control techniques of induction motor, PMSM, BLDC & SRM motors.

Course Objectives:
- To learn principles of vector control of induction motor drive.
- To illustrate sensor less control technique for speed control of induction motor drive.
- To illustrate the concepts of direct control of induction motor drive.
- To learn the modeling aspects and control strategies of PMSM and BLDC motors.
- To learn the basics of SRM control.

UNIT - I
Vector Control of Induction Motor Drive:
Principle of scalar and vector control, direct vector control, indirect vector control, rotor flux oriented control, stator flux oriented control, air gap flux oriented control, decoupling circuits.

UNIT - II
Sensor less Control of induction Motor Drive:
Advantages of speed sensor less control, voltage current based speed sensor less control, MRAS-model reference adaptive systems, Extended Kalman filter observers.

UNIT - III
Direct Torque Control of Induction Motor Drive:
Principle of Direct torque control (DTC), concept of space vectors, DTC control strategy of induction motor, comparison between vector control and DTC, applications, space vector modulation based DTC of induction motors.

UNIT - IV
Control of Permanent Magnet Synchronous Machines (PMSM) and Brushless DC (BLDC) Motor Drives:
Advantages and limitations of Permanent magnet machines, operating principle of PMSM, modeling of PMSM, operating principle BLDC motor, modeling of BLDC motor, similarities and difference between PMSM and BLDC motors , need for position sensing in BLDC motors, control strategies for PMSM and BLDC, methods of reducing torque ripples of BLDC motor.

UNIT - V
Control of Switched Reluctance Motor (SRM) Drive:
SRM structure, Merits and limitations, stator excitation, converter topologies, SRM waveforms, Torque control schemes, speed control of SRM, torque ripple minimization, instantaneous -torque control using current controllers and flux controllers

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Course Outcomes:

After the completion of the course the student should be able to:

- Understand the concepts of vector control methods for Induction Motor drive systems.
- Understand the principle of sensor less control of Induction Motor drive.
- Understand the principle of DTC of Induction Motor drive.
- Learn the modeling & control aspects of PMSM and BLDC Motor drives.
- Understand the construction operation and control aspects of SRM.

Text Books:

1. Bose B. K., "Power Electronics and Variable Frequency Drives",IEEE Press, Standard Publisher Distributors. 2001.
2. Power electronic converters applications and design-Mohan, Undeland, Robbins-Wiley publications

Reference Books:

1. Krishnan R., “Electric Motor Drives – Modeling, Analysis and Control”, Prentice Hall of India Private Limited.
2. Switched Reluctance Motors and Their Control- T. J. E. Miller, Magna Physics, 1993.

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF ELECTRICAL CIRCUITS (Minors Engineering Course)					

Preamble:
Electrical circuit analysis is one of the most vital aspects of electrical & electronics engineering. Understanding how components work individually and collectively is the basis for designing electrical & electronics circuits. This course covers the aspects of various circuit components, laws, network theorems and analysis of single phase & three phase AC systems.

Course Objectives
- To learn about passive elements, sources, node and mesh analysis.
- To understand the basic concepts of single-phase AC systems.
- To learn network theorems and their applications to analyze electrical circuits.
- To analyze three-phase balanced and unbalanced circuits
- To perform transient analysis of RL, RC & RLC circuits

UNIT - I
Introduction to Electrical Circuits
Basic Concepts of passive elements of R, L, C and their V-I relations, Sources (dependent and independent), Kirchoff's laws, Network reduction techniques (series, parallel, series - parallel, star-to-delta and delta-to-star transformation), source transformation technique, nodal analysis and mesh analysis to DC networks with dependent and independent voltage and current sources.

UNIT - II
Single Phase A.C Systems
Periodic waveforms (determination of rms, average value and form factor), concept of phasor, phase angle and phase difference – waveforms and phasor diagrams for lagging, leading networks, complex and polar forms of representations-node and mesh analysis.

Steady state analysis of R, L and C circuits, power factor and its significance, real, reactive and apparent power, waveform of instantaneous power and complex power .

UNIT - III
Network theorems (DC & AC Excitations)
Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

UNIT - IV
Balanced and Unbalanced Three phase circuits
Analysis of three phase balanced circuits:
Phase sequence, star and delta connection of sources and loads, relation between line and phase voltages and currents, analysis of balanced three-phase circuits, measurement of active and reactive power.
Analysis of three phase unbalanced circuits:
Loop method, Star-Delta transformation technique, two wattmeter method for measurement of three phase power.

UNIT - V
Transient Analysis in DC & AC Circuits
Transient response of First order (R-L, R-C) and second order (R-L-C) circuits using Laplace transforms.

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Course Outcomes:

After the completion of the course the student should be able to:

- Understand about the basic elements of electrical circuits.
- Learn to do steady state analysis of single-phase AC systems.
- Apply network theorems to analyze electrical circuits.
- Learn to analyze three-phase balanced and unbalanced circuits
- Perform transient analysis of different RL, RC & RLC circuits

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley, McGraw Hill Company, 9th edition, 2018.
2. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India), 6th edition, 2019

Reference Books:

1. Network analysis: Van Valkenburg: Prentice-Hall of India Private Ltd, 3rd edition, 2019.
2. Electric Circuits by David A. Bell, Oxford publications, 7th edition, 2009.
3. Circuit Theory (Analysis and Synthesis) by A.Chakrabarthi, Dhanpat Rai & Co, 7th - Revised edition, 2018).

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA–533003, Andhra Pradesh, India
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

II Year – II SEMESTER		L	T	P	C
		3	0	0	3
CONCEPTS OF ELECTRICAL MEASUREMENTS **(Minors Engineering Course)**					

Preamble:
The development of technologies in the measurement system leads on the periphery of interest. It provides a vital knowledge on analog & digital measuring Instruments.

Course Objectives:
- Interpret the working principles of various analog measuring Instruments.
- To understand the concept behind power and Energy measurements procedures.
- Calculate the resistance, inductance and capacitance using various bridges.
- Evaluate the importance and understand the concept of various transducers.
- To understand the various types of digital meters and their functionality.

UNIT – I
Analog Ammeter and Voltmeters
Classification – deflecting - control and damping torques – Construction of PMMC - Moving Iron and Electrodynamo instruments - Torque equation - Errors and Compensation – Numerical Problems.

UNIT – II
Analog Wattmeters and Energy Meters
Electrodynamometer type wattmeter (LPF and UPF) - Induction Type Energy meters-Construction and working - Errors and Compensation– Numerical Problems.

UNIT – III
Measurements of Electrical parameters
DC Bridges: Measurement of Resistance – Kelvin's double bridge - Wheatstone bridge – Numerical Problems.
AC Bridges: Measurement of inductance and quality factor - Maxwell's bridge - measurement of capacitance - Schering Bridge– Numerical Problems.

UNIT – IV
Transducers
Classification - Resistive (Strain Gauge) - Inductive (LVDT) and Capacitive (Piezo electric) Transducer – Numerical Problems.

UNIT – V
Digital Meters
Successive approximation Digital Voltmeter — Digital frequency meter - Digital multimeter - Digital Energy Meter.

Course Outcomes:
After the completion of the course the student should be able to:
- Choose right type of instrument for measurement of ac and dc voltage and current.
- Analyse the operation of wattmeter and energy meter.
- Differentiate the operation of AC and DC bridges.
- Describe the operation various Transducers.
- Know the importance of Digital Meters and their working principles.

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Text Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications - 19th revised edition - 2011.
2. Electronic Instrumentation by H.S.Kalsi - THM.

Reference Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.
3. Electrical and Electronic Measurements and instrumentation by R.K.Rajput - S.Chand - 3rd edition.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
ANALYSIS OF LINEAR SYSTEMS **(Minors Engineering Course)**					

Preamble:
This course introduces the basics of Electrical Networks, state space analysis, applications of Laplace, Fourier series and Fourier transform. It also deals with Z-Transforms and testing of polynomial and network synthesis.

Course Objectives: formulate

- To formulate state equation for electrical networks and analysis simple networks with state variable approach.
- To analyze the signals applied to electrical networks and theorems.
- To examine the applications of Fourier series, Fourier transform to simple circuits.
- To know the distinction between Laplace, Fourier and Z-Transforms.
- To evaluate testing of polynomials and network synthesis of LC, RC and RL networks.

UNIT - I
State Variable Analysis
Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.

UNIT - II
Laplace Transform Applications
Application of Laplace transform methods of analysis:
Response of RL, RC and RLC networks to step, ramp, pulse and impulse functions, shifting and scaling theorems-Laplace transform of periodic functions-Convolution theorem-Convolution integral-Applications.

UNIT - III
Application of Fourier Series and Fourier Transform
Fourier Series: RMS, average value of a non-sinusoidal periodic wave form-Expression for power with non sinusoidal voltage and current-Power factor-Effect of harmonics-Analysis of simple circuits with non-sinusoidal inputs.
Fourier Transform: Representation of non-periodic functions-Fourier integral-Fourier transform-Graphical Representation-Properties of Fourier transforms-Parseval's theorem-Fourier transform of constant, unit step, unit impulse, unit ramp signals and exponential functions-relationship with Laplace transform.

UNIT - IV
Z-Transforms
Fundamental difference between continuous and discrete time signals, discrete time complex, exponential and sinusoidal signals, periodicity of discrete time complex exponential, concept of Z-Transform of a discrete sequence. Distinction between Laplace, Fourier and Z-Transforms. Region of convergence in Z-Transforms, constraints on ROC for various classes of signals, Inverse Z-Transform properties of Z-Transforms.

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UNIT - V

Testing of Polynomials and Network synthesis:

Elements of realisability-Hurwitz polynomials-positive real functions-Properties-Testing-Sturm's Test, examples.

Network synthesis:

Synthesis of one port LC networks-Foster and Cauer methods-Synthesis of RL and RC one port networks-Foster and Cauer methods.

Course Outcomes:

After the completion of the course the student should be able to:

- Solve problems involving continuous time signals and linear systems.
- Use the Laplace transform to analyse signals, linear circuits and systems.
- Use the Fourier series and transform to analyse signals.
- Solve problems involving discrete time signals and linear systems.
- Illustrate testing of polynomials and network synthesis of LC, RC and RL networks.

Text Books:

1. Signals, Systems and Communications by B.P. Lathi, BS Publications 2003.
2. Network Analysis and Synthesis – B C Kuo
3. Network Analysis and Synthesis – Umesh Sinha- Satya Prakashan Publications

Reference Books:

1. Linear System Analysis – A N Sripathi, New Age International
2. Network and Systems – D Roy Chowdhary, New Age International
3. Engineering Network Analysis and Filter Desgin- Gopal G Bhise & Umesh

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
ENERGY AUDITING, CONSERVATION AND MANAGEMENT **(Minors Engineering Course)**					

Preamble:

This course is developed to cater the current needs of the industry. This course covers topics on Energy Audit, methodology, energy efficient lighting system, Energy Instruments and Economic Analysis. The student will learn various improvement techniques, energy efficiency in HVAC systems.

Course Objectives:

- To understand basic concepts of Energy Audit & various Energy conservation schemes.
- To design energy an energy management program.
- To understand concept of Energy Efficient Motors and lighting control efficiencies.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Unit–I
Basic Principles of Energy Audit
Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry - thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017) -

Unit–II:
Energy Management
Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.

Unit–III:
Energy Efficient Motors and Lighting
Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

Unit–IV
Power Factor Improvement And Energy Instruments
Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on p.f - p.f motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.

Unit–V
Economic Aspects and Their Computation
Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

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Course Outcomes:

After the completion of the course the student should be able to:

- Understand the principles of energy audit along with various Energy related terminologies.
- Asses the role of Energy Manager and Energy Management program.
- Design a energy efficient motors and good lighting system.
- Analyse the methods to improve the power factor and identify the energy instruments for various real time applications.
- Evaluate the computational techniques with regard to economic aspects.

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth - Heinemann publications - 1982.
2. Energy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

EVOLUTIONARY ALGORITHMS
(Minors Engineering Course)

Preamble:
Evolutionary algorithms use mechanisms inspired by nature and they can be used to solve optimization problems through process that emulate the behaviors of living organisms. In this course students learn different evolutionary algorithms and their applications to solve standard single-objective test problems.

Course Objectives:
- To classify optimization problems and learn the features of soft computing algorithms.
- To learn the steps of GA and PSO algorithms and their applications to solve Rosenbrock & Rastrigin function test problems.
- To learn HSA and ABC algorithms & their application to solve Rosenbrock & Rastrigin function test problems.
- To illustrate the steps of SFLA & Bat optimization algorithms & their application to solve standard single objective test problems.
- To learn the basic concepts of multi-objective optimization & steps of NSGA-II algorithm.

UNIT - I
Fundamentals of Soft Computing Techniques
Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Soft computing techniques- Conventional Computing versus Soft Computing - Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Discrete and continuous optimization problems - Single objective and multi-objective problems.

UNIT - II
Genetic Algorithm and Particle Swarm Optimization
Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving standard Rosenbrock, Rastrigin function test problems.

UNIT - III
Harmony Search Optimization and Artificial Bee Colony Algorithms
Harmony Search algorithm – steps – Harmony memory initialization, New harmony improvisation, Harmony memory update – Improved Harmony search algorithm.
Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-HSA and ABC algorithms to solve Rosenbrock & Rastrigin function test problems.

UNIT - IV
Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm
Bat Algorithm- Echolocation of bats- Behaviour of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation- BA and SFLA algorithms to solve Rosenbrock & Rastrigin function test problems..

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UNIT - V

Multi Objective Optimization

Multi-Objective optimization Introduction- Concept of Pareto optimality - Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to solve general two objective optimization problem.

Course Outcomes:

After the completion of the course the student should be able to:

- State and formulate the optimization problem, without and with constraints, by using design variables.
- Apply GA and PSO algorithms to solve single objective optimization problems
- Apply HSA and ABC algorithms to solve single objective optimization problems
- Apply Bat and SFL algorithms to solve single objective optimization problems
- Formulate multi-objective optimization problem and use NSGA-II to solve two objective optimization problem

Text Books

1. Xin-She Yang, „Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb „Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, „Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.

Reference Books:

1. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, „Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
2. David Goldberg, „Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
3. Konstantinos E. Parsopoulos and Michael N. Vrahatis, „Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIon scIence reference, IGI Global, , 2010.
4. N P Padhy, „Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

Reference Papers:

1. "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization" by Muzaffar eusuff, Kevin lansey and Fayzul pasha, Engineering Optimization, Taylor & Francis, Vol. 38, No. pp.129–154, March 2006.
2. "A New Metaheuristic Bat-Inspired Algorithm" by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J. R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).
3. K. Nekooei, M. M. Farsangi, H. Nezamabadi-Pour and K. Y. Lee, "An Improved Multi-Objective Harmony Search for Optimal Placement of DGs in Distribution Systems," in *IEEE Transactions on Smart Grid*, vol. 4, no. 1, pp. 557-567, March 2013, doi: 10.1109/TSG.2012.2237420.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF POWER ELECTRONICS **(Minors Engineering Course)**					

Preamble:
The usage of power electronics in day to day life has increased in recent years. It is important for student to understand the fundamental principles behind all power electronic converters. This course covers characteristics of semiconductor devices and operation of ac/dc, dc/dc, ac/ac and dc/ac converters. The importance of using pulse width modulated techniques to obtain high quality power supply (dc/ac converter) is also discussed in detail in this course.

Course Objectives:
- To know the characteristics of various power semiconductor devices.
- To learn the operation of single phase full–wave converters and perform harmonic analysis of input current.
- To learn the operation of three phase full–wave converters and AC/AC converters.
- To learn the operation of different types of DC-DC converters.
- To learn the operation of PWM inverters for voltage control and harmonic mitigation.

UNIT – I
Power Semi-Conductor Devices
Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics
Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems.

UNIT – II
Single-phase AC-DC Converters
Single-phase half wave controlled rectifiers - R load and RL load with and without freewheeling diode - Single-phase fully controlled bridge converter with R load - RL load and RLE load - Continuous and Discontinuous conduction - Expression for output voltages – Single-phase Semi-Converter with R load - RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis - Numerical Problems.

UNIT – III
Three-phase AC-DC Converters & AC – AC Converters
Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Harmonic Analysis - Numerical Problems.
AC-AC power control by phase control with R and RL loads - Expression for rms output voltage- Numerical problems.

UNIT – IV
DC–DC Converters
Analysis of Buck - Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple- Numerical Problems.

UNIT - V
DC–AC Converters
Introduction - Single-phase half bridge and full bridge inverters with R and RL loads – Three-phase square wave inverters - 120^0 conduction and 180^0 conduction modes of operation - PWM inverters - Sinusoidal Pulse Width Modulation - Numerical Problems.

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Course Outcomes:

After the completion of the course the student should be able to:

- Illustrate the static and dynamic characteristics SCR - Power MOSFET and Power IGBT.
- Analyse the operation of phase controlled rectifiers.
- Analyse the operation of Three-phase full–wave converters - AC Voltage Controllers and Cyclo-converters.
- Examine the operation and design of different types of DC-DC converters.
- Analyse the operation of PWM inverters for voltage control and harmonic mitigation.

Text Books:

1. Power Electronics: Converters - Applications and Design by Ned Mohan - Tore M Undeland - William P Robbins - John Wiley & Sons.
2. Power Electronics: Circuits - Devices and Applications – by M. H. Rashid - Prentice Hall of India - 2nd edition - 1998
3. Power Electronics: Essentials & Applications by L. Umanand - Wiley - Pvt. Limited - India - 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. Oxford University Press; Second edition
2. Power Electronics – by P.S.Bhimbra - Khanna Publishers.
3. Power Electronics: by Daniel W.Hart - Mc Graw Hill.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
NEURAL NETWORKS AND FUZZY LOGIC (Minors Engineering Course)					

Preamble:
This course introduces the basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks. Also deals with Associate Memories and introduces Fuzzy sets and Fuzzy Logic system components. The Neural Network and Fuzzy Network system application to Electrical Engineering is also presented. This subject is very important and useful for doing Project Work.

Course Objectives:
- To understand artificial neuron models & learning methods of ANN.
- To utilize different algorithms of ANN.
- To distinguish between classical and fuzzy sets.
- To illustrated different modules of fuzzy controller.
- To analyze applications of neural networks and fuzzy logic.

UNIT - I
Introduction
Artificial Neural Networks (ANN) – Humans and Computers – Biological Neural Networks – ANN Terminology – Models of Artificial Neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised - unsupervised and reinforced) – Neural networks learning rules.

UNIT - II
Feed Forward Networks:
Single Layer Feed Forward Neural Networks: Concept of Pattern And Its Types - Perceptron Training and Classification Using Discrete and Continuous Perceptron Algorithms– Linear Separability- XOR Function.

UNIT - III
ANN Paradigms
Multi-layer feed forward networks –Generalized delta rule– Back Propagation algorithm – Radial Basis Function (RBF) network - Kohonen's self-organizing feature maps (KSOFM) – Bidirectional Associative Memory (BAM).

UNIT - IV
.Classical and Fuzzy Sets
Introduction to classical sets- properties - Operations and relations;
Fuzzy sets - Operations - Properties - Fuzzy relations - Cardinalities - Membership functions.

UNIT - V
Fuzzy Logic Modules
Fuzzification - Membership value assignment - development of rule base and decision making system - Defuzzification to crisp sets - Defuzzification methods.

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Course Outcomes:

After the completion of the course the student should be able to:

- Analyse different models of artificial neuron.
- Illustrate training and classification using perceptron algorithms.
- Evaluate different paradigms of ANN.
- Classify between classical and fuzzy sets.
- Analyse various modules of Fuzzy logic controller.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda - Jaico Publishing House - 1997.
2. Neural Networks -Fuzzy logic - Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.

Reference Books:

1. Artificial Neural Network – B.Yegnanarayana - PHI - 2012.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc - 1997.
3. Introduction to Neural Networks using MATLAB 6.0 – S N Sivanandam – S. Sumathi - S N Deepa TMGH
4. Introduction to Fuzzy Logic using MATLAB – S N Sivanandam – S. Sumathi - S N Deepa Springer - 2007.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3

CONCEPTS OF ELECTRIC DRIVES AND ITS APPLICATIONS
(Minors Engineering Course)

Preamble:
This course covers in detail the basic speed control techniques of DC and AC motors using power electronic converters.

Course Objectives:
- To learn the fundamentals of electric drive & different electric braking methods.
- To analyse the operation of phase controlled converter fed DC motor drives.
- To analyze the operation of DC-DC converter fed DC motor drives.
- To illustrate the speed control of induction motor by stator and rotor side control.
- To learn the speed control mechanism of synchronous motors.

UNIT – I
Fundamentals of Electric Drives
Electric drive and its components– Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

UNIT – II
Controlled Converter Fed DC Motor Drives
3-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics -Numerical problems.

UNIT – III
DC–DC Converters Fed DC Motor Drives
Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current mode of operation - Output voltage and current waveforms – Speed–torque expressions and characteristics.

UNIT – IV
Stator and Rotor side control of 3-phase Induction motor Drive
Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter. Static rotor resistance control– Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics.

UNIT - V
Control of Synchronous Motor Drives
Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only).

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Course Outcomes:

After the completion of the course the student should be able to:

- Explain the fundamentals of electric drive and different electric braking methods.
- Analyze the operation of Three-phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
- Describe the DC-DC converter control of dc motors in various quadrants of operation
- Understand `the concept of speed control of induction motor by using AC voltage controllers, voltage source inverters and rotor side control.
- Understand the speed control mechanism of synchronous motors.

Text Books:

1. Fundamentals of Electric Drives – by G K Dubey - Narosa Publications - 2nd edition 2002.
2. Power Semiconductor Drives - by S.B.Dewan - G.R.Slemon - A.Straughen - Wiley-India - 1984.

ACADEMIC REGULATIONS

COURSE STRUCTURE & DETAILED SYLLABUS

For

B.Tech FOUR YEAR DEGREE COURSE

(Applicable for the batches admitted from 2019-20)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533003, ANDHRA PRADESH, INDIA

ACADEMIC REGULATIONS (R19) FOR B. TECH. (REGULAR)

Applicable for students of B. Tech. (Regular) from Academic Year 2019-20 onwards

Jawaharlal Nehru Technological University Kakinada (JNTUK) 2019 Regulations (R19 Regulations) applicable to all affiliated colleges are given hereunder. These regulations govern the B. Tech programmes offered by all affiliated colleges with effect from the students admitted to the programmes in academic year 2019-20.

1. Courses of study:

The following courses of study are offered at present as specializations for the B. Tech. Courses in the jurisdiction of all affiliated colleges of JNTUK.

S. No	Branch	Short Name	Code
1	Civil Engineering	CE	01
2	Electrical & Electronics Engineering	EEE	02
3	Mechanical Engineering	ME	03
4	Electronics and Communication Engineering	ECE	04
5	Computer Science Engineering	CSE	05
6	Electronics and Instrumentation Engineering	EIE	10
7	Information Technology	IT	12
8	Automobile Engineering	AME	24
9	Mining Engineering	MM	26
10	Petroleum Engineering	PE	27
11	Agriculture Engineering	AGE	35

2. Medium of Instruction: The medium of instruction of the entire B. Tech undergraduate programme in Engineering & Technology (including examinations and project reports) will be in English only.

3. Admissions: Admission to the B. Tech Programme shall be made subject to the eligibility, qualifications and specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either on the basis of the merit rank obtained by the student in the common entrance examination conducted by the A.P. Government/University or on the basis of any other order of merit approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

4. Programme Pattern:

a) Total duration of the of B. Tech (Regular) Programme is four academic years
b) Each Academic year of study is divided in to **two semesters**.
c) Minimum number of instruction days in each semester is 90.
d) Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).
e) The total credits for the Programme is 160.
f) Induction program is mandatory for all first year UG students and shall be conducted as per AICTE/UGC guidelines.

g) Student is introduced to "Choice Based Credit System (CBCS)".
h) A student has to register for all courses in a semester.
i) All the registered credits will be considered for the calculation of final CGPA.
j) Each semester has - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and course structure as suggested by AICTE are followed.

5. Subject/Course Classification: All subjects/courses offered for the undergraduate programme in E & T (B. Tech degree programmes) are broadly classified as follows.

S. No	Broad Course Classification	Course Group/Category	Course Description
1	BS	Basic Science Courses	Basic Science Courses
2	ES	Engineering Science Courses	Includes Engineering subjects
3	HS	Humanities and Social sciences	Includes Management courses
4	PC	Professional Core Courses	Includes core subjects related to the parent discipline/ department/ branch of Engineering.
5	PE	Professional Elective Courses	Includes elective subjects related to the parent discipline/ department/ branch of Engineering.
6	OE	Open Elective Courses	Electives from other technical and/or emerging subjects
7	LC	Laboratory Courses	Laboratory Courses
8	MC	Mandatory Courses	Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge
9	PR	Project Work	Project work, seminar and internship in industry or elsewhere

6. Award of B. Tech. Degree: A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

i. A student shall be declared eligible for award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years.
ii. After eight academic years from the year of their admission, he/she shall **forfeit** their seat in B. Tech course and their admission stands cancelled.
iii. The student shall register for 160 credits and must secure all the 160 credits.
iv. Credit Definition:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit
2 Hours Practical(Lab) per week	1 Credit

7. Attendance Requirements

(a) A student is eligible to write the University examinations if he acquires a minimum of 50% in each subject and 75% of attendance in aggregate of all the subjects.

(b) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) may be granted by the College Academic Committee. However this

condonation concession is applicable only to any two semesters during the entire programme.

(c) Shortage of Attendance below 65% in aggregate shall not be condoned.

(d) A student who is short of attendance in a semester may seek re-admission into that semester when offered within 4 weeks from the date of commencement of class work.

(e) Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.

(f) A stipulated fee of Rs. 500/- shall be payable towards condonation of shortage of attendance.

(g) A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.

(h) If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

8. Question paper setting- Distribution and Weightage of marks - Evaluation and Assessment:

(i) Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the University Examination section from time to time.

(ii) Distribution and Weightage of marks:

The assessment of the student's performance in each course will be based on Continuous Internal Evaluation (CIE) and Semester-End Examination (SEE). The performance of a student in each semester shall be evaluated subject–wise with a maximum of 100 marks for theory subject and 50 marks for practical subject. For theory subjects the distribution shall be 25 marks for Internal Evaluation and 75 marks for the End Examinations.

S. No	Components	Internal	External	Total
1	Theory	25	75	100
2	Engineering Graphics/Design/Drawing	25	75	100
3	Practical	20	30	50
4	Mini Project/Internship/Industrial Training/ Skill Development programmes/Research Project	-	50	50
5	Project Work – Part I	20	30	50
5	Project Work – Part II	60	90	150

(iii) Continuous Internal Theory Evaluation:

For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one online objective examination (ii) one descriptive examination and (iii) one assignment. The online examination (objective) and descriptive examination shall be for 10 marks each with a total duration of 1 hour 50 minutes (20 minutes for objective and 90 minutes for descriptive paper). The online examination (objective) is set with 20 multiple choice questions for 10 marks (20 questions x ½ marks) from first two and half units (50% of the syllabus) and it is conducted by **University Examination Section.** The descriptive examination is set with 3 full questions from first two and half units (50% of the syllabus), the student has to answer all questions. The second online examination shall be conducted on the rest of the syllabus. The assignment is given by the concerned class teacher for five marks from first two and half units (50% of the syllabus). The second assignment shall given from rest of the syllabus. The first assignment should be submitted before the conduct of the first mid-term examination, and the second

assignment should be submitted before the conduct of the second mid-term examination. The total marks secured by the student in each mid-term examination are evaluated for 25 marks. The first mid marks (Mid-1) consisting of marks of online objective examination, descriptive examination and assignment shall be submitted to the University examination section within one week after completion of first mid examination. The mid marks submitted to the University examination section shall be displayed in the concerned college notice boards for the benefit of the students. If any discrepancy found in the submitted mid-1 marks, it shall be brought to the notice of university examination section within one week from the submission. Second mid marks (Mid-2) consisting of marks of online objective examination, descriptive examination and assignment shall also be submitted to University examination section within one week after completion of second mid examination and it shall be displayed in the notice boards. If any discrepancy found in the submitted mid-2 marks, it shall be brought to the notice of university examination section within one week from the submission. Internal marks can be calculated with 80% weightage for better of the two mids and 20% Weightage for other mid exam.

Example:

Mid-1 marks = Marks secured in (online examination-1+descriptive examination-1+one assignment-1)

Mid-2 marks = Marks secured in (online examination-2+descriptive examination-2+one assignment-2)

Final internal Marks = (Best of (Mid-1/Mid-2) marks x 0.8 + Least of (Mid-1/Mid-2) marks x 0.2)

With the above criteria, university examination section will send mid marks of all subjects in consolidated form to all the concerned colleges and same shall be displayed in the concerned college notice boards. If any discrepancy found, it shall be brought to the notice of university examination section through proper channel within one week with all proofs. Discrepancies brought after the given deadline will not be entertained under any circumstances.

(iv) **Semester End Theory Examinations Evaluation:** The semester end examinations will be conducted university examination section for 75 marks consists of five questions carrying 15 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

(v) For practical subjects there shall be continuous evaluation during the semester for 20 internal marks and 30 end examination marks. The internal 20 marks shall be awarded as follows: day to day work - 5 marks, Record-5 marks and the remaining 10 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the teacher concerned and external examiner appointed by controller of examinations, JNTUK.

Note: Laboratory marks and the internal marks awarded by the College are not final. The marks are subject to scrutiny and scaling by the University wherever felt desirable. The internal and laboratory marks awarded by the College will be referred to a Committee. The Committee shall arrive at a scaling factor and the marks will be scaled as per the scaling factor. The recommendations of the Committee are final and binding. All the laboratory records and internal test papers shall be preserved in respective departments as per University norms and shall be produced to the Committees of University as and when they ask for.

(vi) For the subject having design and / or drawing, (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 25 marks for internal evaluation (15 marks for continuous Assessment (day–to–day work) and 10 marks for

internal tests) and 75 marks for end examination. There shall be two internal tests in a Semester for 10 marks each and final marks can be calculated with 80% weightage for better of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day to day work.

(vii) *Project Work I*:

The object of Project Work I is to enable the student to take up investigative study in the broad field of concerned branch of specialization, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or a group of students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

a) Survey and study of published literature on the assigned topic;
b) Working out a preliminary approach to the problem relating to the assigned topic;
c) Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/ Feasibility
d) Preparing a written report on the study conducted for presentation to the department;
e) Final Seminar, as oral Presentation before a departmental committee.
f) The evaluation of the Project Work I will be done as per the procedure suggested by the university

Evaluation: The total marks for Project Work I is 50 marks and distribution shall be 20 marks for internal and 30 marks for external evaluation. The supervisor assesses the student for 10 marks (Continuous Assessment: 5 marks, Report –5 marks). At the end of the semester, projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee consists of supervisor, a senior faculty and HOD for 10 marks. The external evaluation of Project Work I is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the University and is evaluated for 30 marks.

(viii) *Project Work II*:

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under Project Work I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

a) In depth study of the topic assigned in light of Report prepared under Project Work I;
b) Review and finalization of the approach to the problem relating to the assigned topic;
c) Preparing an Action Plan for conducting the investigation, including team work;
d) Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed;
e) Final development of product/process, testing, results, conclusions and future directions;
f) Preparing a paper for Conference presentation/publication in Journals, if possible;
g) Preparing a dissertation in the standard format for being evaluated by the department;
h) The evaluation of the Project Work II will be done as per the procedure suggested by the university.

Evaluation: The total marks for project work II is 150 marks and distribution shall be 60 marks for internal and 90 marks for external evaluation. The supervisor assesses the student for 30 marks (Continuous Assessment: 15 marks, Report –15 marks). At the end of the semester, projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee

consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work II is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the University and is evaluated for 90 marks.

Note: Project Work II is a continuation of Project Work I with same supervisor and it is not allowed to change the topic and area. If the Project is continued at R&D laboratory/Industry, another supervisor may be added from the concerned organization.

(ix) For Socially Relevant Project there shall be continuous evaluation during the semester for 20 internal marks and 30 external marks.

Internal Evaluation (20 Marks): Two internal evaluations in the form of presentations (First one before I Mid-term and Second one before the II-Mid-term examinations) shall be conducted by the supervisor and a faculty member nominated by the HOD. For a total of 20 marks, 80% of best one of the two evaluation and 20% of the other evaluation are added and finalized.

External Semester Evaluation (30 Marks): A report on socially relevant project shall be submitted by group of students to the department at the end of the semester. The Viva-Voce examination shall be conducted by the committee consisting of internal examiner (supervisor) and external examiner appointed by the University. The Viva-Voce examination shall be planned along end semester practical examinations.

(x) Mandatory Course (M.C): There shall be Mandatory Course with zero credits. There shall be no external examination. However, a minimum of 75% attendance is mandatory in that particular subject.

(xi) Engineering Exploration Course: The motivation of including Engineering Exploration Project in the curriculum is to make the students practice creative problem solving method - Design Thinking which fosters collaboration and solve problems in human-centered ways. It enables the students to exercise and identify design opportunities through various phases with the help of hands-on activities. Obtaining a best solution for an identified problem involves a non-linear, iterative process which seeks to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. The students are encouraged to explore real-world problems and expected to take charge of their own learning, work together in teams towards the problem. The evaluation of the Engineering Exploration Project involves in writing their observations in Activity Cards at the end of each task given in syllabus and submitting a final report along with working prototype.

***Evaluation*:** For Engineering Exploration Project there shall be continuous evaluation during the semester for 20 internal marks and 30 external marks.

Internal Evaluation (20 Marks): Two internal evaluations in the form of presentations (First one before I Mid-term and Second one before the II-Mid-term examinations) shall be conducted by the supervisor and a faculty member nominated by the HOD. For a total of 20 marks, 80% of best one of the two evaluation and 20% of the other evaluation are added and finalized.

External Semester Evaluation (30 Marks): A report on socially relevant project shall be submitted by group of students to the department at the end of the semester. The Viva-Voce examination shall be conducted by the committee consisting of internal examiner (supervisor) and external examiner appointed by the University. The Viva-Voce examination shall be planned along end semester practical examinations.

(xii) **Procedure for Conduct and Evaluation of MOOC:** There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by

SWAYAM/NPTEL/JNTUK MOOCS through online with the approval of Head of the Department. The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal in the previous semester. During the course, the mentor monitors the student's assignment submission given by SWAYAM/NPTEL at the end of every week. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate.

For JNTUK MOOCS course, the mentor appointed shall conduct the mid semester examinations as per 8(iii). Further, the University shall conduct the external examination for the MOOC subject in line with other regular subjects based on the syllabi of the respective subject provided in the curriculum. A MOOC course may be studied either in online or in conventional manner. In case if student does not pass in SWAYAM/NPTEL, the alternative subject may be taken from JNTUK MOOCS and has to pass the course as per 8(iii) and 8(iv). Open Electives are evaluated as per 8(iii) and 8(iv).

(xiii) Mini Project/Internship/Industrial Training/Skill Development programmes/Research Project guidelines: There shall be a Mini Project/Internship/Industrial Training/Skill Development programmes/Research Project, in collaboration with an industry of their specialization. Students shall pursue this course during summer vacation just before its offering as per course structure. The minimum duration of this course is at least 16 hours. The student shall register for the course as per course structure after commencement of academic year. An individual or group of students can take up this course under the guidance of a supervisor from concerned department. The supervisor shall maintain the attendance of the course for the students allotted. Attendance requirements are as per the norms of the University. After completion the students shall be submit a technical report and presented before the committee. A certificate from industry/skill development center shall be included in the report. It shall be evaluated for 50 external marks at the end of the semester. The committee consists of an external examiner appointed by the University; Head of the Department, supervisor of the Mini Project/Internship/Industrial Training/Skill Development programmes/Research Project and a senior faculty member of the department. There shall be no internal marks for Industrial Oriented Mini Project/Summer Internship. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the University.

9. Recounting of Marks in the End Semester Examination: A student can request for recounting of his/her answer book on payment of a prescribed fee as per university norms.

10. Re-evaluation or Revaluation by Challenge of the End Semester Examination: A student can request for Revaluation or Revaluation by Challenge of his/her answer book on payment of a prescribed fee as per university norms.

11. Supplementary Examinations: A student who has failed to secure the required credits can appear for a supplementary examination, as per the schedule announced by the University.

12. Malpractices in Examinations: Disciplinary action shall be taken in case of malpractices during Mid/End examinations as per the rules framed by the University.

13. Minimum Academic Requirements

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.7.

a) A student is deemed to have satisfied the minimum academic requirements if he has earned the credits allotted to each theory/practical design/drawing subject/ project etc by securing

not less than 35% of marks in the end semester exam and minimum 40% of marks in the sum total of the internal marks and end semester examination marks together.

b) A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement as per University norm.

c) A student will be promoted from II year to III year if he fulfills the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.

d) A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

e) A student shall register and put up minimum attendance in all 160 credits and earn all 160 credits.

14. Course Pattern

a) The entire course of study is for four academic years; all years are on semester pattern.

b) A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.

c) When a student is detained for lack of credits / shortage of attendance, he may be re-admitted into the same semester / year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

15. Earning of Credit:

A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range O-D as given below. Letter grade 'F' in any course implies failure of the student in that course and no credits earned. Absent is also treated as no credits earned.

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 75)	Level	Letter Grade	Grade Point
≥ 90	≥ 67	Outstanding	O	10
≥80 to <90	≥60 to <67	Excellent	S	9
≥70 to <80	≥52 to <60	Very Good	A	8
≥60 to <70	≥45 to <52	Good	B	7
≥50 to <60	≥37 to <45	Fair	C	6
≥40 to <50	≥30 to <37	Satisfactory	D	5
<40	<30	Fail	F	0
		Absent		0

16. Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

(i) ***SGPA***(S_k) of k^{th} semester (1 to 8) is ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the total number of credits of all the courses undergone/registered by a student, i.e

$$SGPA(S_k) = \frac{\sum_{i=1}^{n} (C_i \times G_i)}{\sum_{i=1}^{n} C_i}$$

Where C_i is the number of credits of the i^{th} course/subject in a semester and G_i is the grade point scored by the student in the i^{th} course/subject and n is the number of courses/subjects registered in that semester.

(ii) CGPA: The CGPA is calculated in the same manner taking into account all the '*m'* courses/subjects registered by student over all the semesters of a Programme i.e., in all eight semesters

$$CGPA = \frac{\sum_{i=1}^{m}(C_i \times S_i)}{\sum_{i=1}^{m} C_i}$$

Where S_i is SGPA of the i^{th} semester and C_i is total number of credits in that semester.

(iii) SGPA and CGPA shall be rounded off to 2 decimal points and reported in transcripts.

(iv) As per AICTE regulations, conversion of CGPA into equivalent percentage as follows:

Equivalent Percentage = (CGPA – 0.75) x 10

(v) Illustration of Computation of SGPA and CGPA

Illustration for **SGPA:** Let us assume there are 6 subjects in a semester. The grades obtained as follows:

Course	Credit	Grade Obtained	Grade point	S_i= Credit Point (Credit x Grade)
Subject 1	3	A	8	3 X 8 = 24
Subject 2	4	B	7	4 X 7 = 28
Subject 3	3	C	6	3 X 6 = 18
Subject 4	3	O	10	3 X 10 = 30
Subject 5	3	D	5	3 X 5 = 15
Subject 6	4	C	6	4 X 6 = 24
	20			139

Thus, **SGPA =139/20 =6.95=6.9 (approx.)**

Illustration for **CGPA:**

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credit : 20 SGPA: 6.9	Credit : 22 SGPA: 7.8	Credit : 25 SGPA: 5.6	Credit : 26 SGPA: 6.0
Semester 5	**Semester 6**	**Semester 7**	**Semester 8**
Credit : 26 SGPA: 6.3	Credit : 25 SGPA: 8.0	Credit : 21 SGPA: 6.4	Credit : 23 SGPA: 7.5

Thus,

$$CGPA = \frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0 + 21 \times 6.4 + 23 \times 7.5}{188} = \frac{1276.3}{188} = 6.78$$

17. Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 160 Credits
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

18. Minimum Instruction Days

The minimum instruction days for each semester shall be 90 working days. There shall be no branch transfers after the completion of the admission process. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

19. Withholding of Results

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

20. Transitory Regulations

(a) Discontinued or detained candidates are eligible for re-admission as and when next offered.

(b) The re-admitted candidate will be governed by the rules & regulations under which the candidate has been admitted.

(c) (i) In case of transferred students from other Universities, credits shall be transferred to JNTUK as per the academic regulations and course structure of JNTU**K.**

(ii) The students seeking transfer to colleges affiliated to JNTUK from various other Universities / Institutions have to obtain the credits of any equivalent subjects as prescribed by JNTUK. In addition, the transferred candidates have to pass the failed subjects at the earlier Institute with already obtained internal/sessional marks to be conducted by JNTUK.

21. General

(a) Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

(b) The academic regulation should be read as a whole for the purpose of any interpretation.

(c) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

(d) The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

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ACADEMIC REGULATIONS (R19) FOR B. TECH. (LATERAL ENTRY SCHEME)

Applicable for the students admitted into II year B. Tech. from the Academic Year 2020-21 onwards

1 **Award of B. Tech. Degree**

A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

a) A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years. After six academic years from the year of their admission, he/she shall **forfeit** their seat in B. Tech course and their admission stands cancelled.

b) The candidate shall register for 120 credits and secure all the 120 credits.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech (lateral entry).

3. **Promotion Rule**

A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.

A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**

After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 120 Credits from II Year to IV Year
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

5. All the other regulations as applicable to **B. Tech. 4-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme)**.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case

	duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action and impose suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student.

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. **Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.**
2. **Ragging entails heavy fines and/or imprisonment.**
3. **Ragging invokes suspension and dismissal from the College.**
4. **Outsiders are prohibited from entering the College and Hostel without permission.**
5. **Girl students must be in their hostel rooms by 7.00 p.m.**
6. **All the students must carry their Identity Cards and show them when demanded**
7. **The Principal and the Wardens may visit the Hostels and inspect the rooms any time.**

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

ACADEMIC REGULATIONS (R20)

COURSE STRUCTURE & DETAILED SYLLABUS

For

B. Tech FOUR YEAR DEGREE COURSE

(Applicable for the batches admitted from 2020-21)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA – 533003, ANDHRA PRADESH, INDIA

ACADEMIC REGULATIONS (R20) FOR B. TECH. (REGULAR)

Applicable for students of B. Tech. (Regular) from Academic Year 2020-21 onwards

Jawaharlal Nehru Technological University Kakinada (JNTUK) 2020 Regulations (R20 Regulations) applicable to all affiliated colleges are given hereunder. These regulations govern the B. Tech programmes offered by all affiliated colleges with effect from the students admitted to the programmes in academic year 2020-21.

1. Courses of study:

The following courses of study are offered at present as specializations for the B. Tech. Courses in the jurisdiction of all affiliated colleges of JNTUK.

S. No	Branch	Short Name	Code
1	Civil Engineering	CE	01
2	Electrical & Electronics Engineering	EEE	02
3	Mechanical Engineering	ME	03
4	Electronics and Communication Engineering	ECE	04
5	Computer Science Engineering	CSE	05
6	Computer Science & Technology	CST	06
7	Electronics and Instrumentation Engineering	EIE	10
8	Information Technology	IT	12
9	Automobile Engineering	AME	24
10	Mining Engineering	MM	26
11	Petroleum Engineering	PE	27
12	Agriculture Engineering	AGE	35
13	Artificial Intelligence and Machine Learning	AIML	42
14	Artificial Intelligence	AI	43
15	Data Science	DS	44
16	Artificial Intelligence and Data Science	AIDS	45
17	Cyber Security	CS	46
18	Internet of things and Cyber security including Block chain Technology	IOTCSBT	47
19	Computer Science and Business System	CSBS	48
20	Internet of Things	IOT	49
21	Electronics & Communication Technology	ECT	50
22	Food Engineering	FE	51

2. **Medium of Instruction:** The medium of instruction of the entire B. Tech undergraduate programme in Engineering & Technology (including examinations and project reports) will be in **English** only.

3. **Admissions:** Admission to the B. Tech Programme shall be made subject to the eligibility, qualifications and specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either on the basis of the merit rank obtained by the student in the common entrance examination conducted by the A.P. Government/University or on the basis of any other order of merit approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

4. Programme Pattern:

a) Total duration of the of B. Tech (Regular) Programme is four academic years
b) Each Academic year of study is divided in to **two semesters**.
c) Minimum number of instruction days in each semester is 90.
d) Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).
e) The total credits for the Programme are 160.
f) A three-week induction program is mandatory for all first year UG students and shall be conducted as per AICTE/UGC/APSCHE guidelines.
g) Student is introduced to "Choice Based Credit System (CBCS)".
h) A pool of interdisciplinary and job-oriented mandatory skill courses which are relevant to the industry are integrated into the curriculum of concerned branch of engineering (total five skill courses: two basic level skill courses, one on soft skills and other two on advanced level skill courses)
i) A student has to register for all courses in a semester.
j) All the registered credits will be considered for the calculation of final CGPA.
k) Each semester has - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and course structure as suggested by AICTE are followed.
l) A 10 months industry/field mandatory internship, both industry and social, during the summer vacation and also in the final semester to acquire the skills required for job and make engineering graduates to connect with the needs of the industry and society at large.
m) All students shall be mandatorily registered for NCC/NSS activities.
n) Each college shall assign a faculty advisor/mentor after admission to each student or group of students from same department to provide guidance in courses registration/career growth/placements/opportunities for higher studies/GATE/other competitive exams etc.

5. Subject/Course Classification: All subjects/courses offered for the undergraduate programme in E & T (B. Tech degree programmes) are broadly classified as follows.

S.No	Category	Code	APSCHE breakup of Credits	AICTE Credits of breakup
1	Humanities and social science including Management courses	HSMC	10.5	12
2	Basic Science courses	BSC	21	25
3	Engineering courses science	ESC	24	24
4	Professional core Courses	PCC	51	48
5	Open Elective Courses	OEC	12	18
6	Professional Courses Elective	PEC	15	18
7	Internship, seminar, project work	PROJ	16.5	15
8	Skill Oriented Courses	SC	10	-
9	Laboratory Courses	LC	-	-
10	Mandatory courses	MC	Non-credit	Non-credit
Total Credits			160	160

6. Registration for Courses:

i) The college shall invite registration forms from the students at the beginning of the semester for the registration for courses each semester. The registration process shall be closed within one week. If any student wishes to withdraw the registration, he/she shall submit a letter to the principal through the class teacher/instructor and HOD. The principal shall communicate the registration and withdraw details courses of each student in a consolidated form to the college examination section and University without fail.

ii) There are four open electives in each branch. All Open Electives are offered to students of all branches in general. A student shall choose an open elective, by consulting the HOD/advisor, from the list in such a manner that he/she has not studied the same course in any form during the Programme.

iii) A student shall be permitted to pursue up to a maximum of two elective courses under MOOCs during the programme. Students are advised to register for only for minimum 12 weeks in duration MOOCs courses. Student has to pursue and acquire a certificate for a MOOC course only from the SWAY/NPTE through online with the approval of Head of the Department in order to earn the 3 credits. The Head of the department shall notify the list of such courses at the beginning of the semester. The details of the MOOCs courses registered by the students shall be submitted to the University examination center as well as college examination center. The Head of the Department shall appoint a mentor for each of the MOOC subjects registered by the students to monitor the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed.

iv) Two summer internships each with a minimum of six weeks duration shall be mandatorily done/completed respectively at the end of second and third years (during summer vacations). The internship can be done by the students at local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs. After completing the summer internship, the students shall register in the immediate respective odd semester and it will be evaluated at the end of the semester as per norms of the university. The student has to produce the summer internship satisfactory report and certificate taken from the organization to be considered for evaluation. The College shall facilitate and monitor the student internship programs. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the internship.

v) In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner.

vi) Curricular Framework for Skill oriented courses

   a) There are five (05) skill-oriented courses shall be offered during III to VII semesters and students must register and pass the courses successfully.
   b) For skill oriented/skill advanced course, one theory and 2 practical hours (1-0-2) or two theory hours (2-0-0) may be allotted as per the decision of concerned BOS.
   c) Out of the five skill courses; (i) two shall be skill-oriented courses from the same domain and shall be completed in second year (ii) Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or job-oriented skill courses, which can be of inter disciplinary nature.
   d) Students may register the interdisciplinary job-oriented skill courses based on the prerequisites and eligibility in consultation with HOD of the college.

e) The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course being offered by industries/Professional bodies/APSSDC or any other accredited bodies. However, the department has to assign mentors in the college to monitor the performance of the students.

f) If a student chooses to take a Certificate Course offered by industries/Professional bodies/APSSDC or any other accredited bodies, in lieu of the skill advanced course offered by the Department, then the department shall mark overall attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate. However, the student is deemed to have fulfilled the attendance requirement of the course, if the external agency issues a certificate with satisfactory condition. If the certificate issued by external agency is marked with unsatisfactory condition, then the student shall repeat the course either in the college or at external agency. The credits will be awarded to the student upon producing the successful Course Completion Certificate from the agency/professional bodies and after passing in the viva-voce examination conducted at college as per university norms at the end of the semester.

7. (a) Award of B. Tech. Degree: A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

i) A student shall be declared eligible for award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years.

ii) After eight academic years from the year of their admission, he/she shall **forfeit** their seat in B. Tech course and their admission stands cancelled.

iii) The student shall register for 160 credits and must secure all the 160 credits.

iv) All students shall register for NCC/NSS activities and will be required to participate in an activity specified by NSS officer during second and third semesters. Grade shall be awarded as Satisfactory or Unsatisfactory in the mark sheet on the basis of participation, attendance, performance and behavior. If a student gets an unsatisfactory Grade, he/she shall repeat the above activity in the subsequent years, in order to complete the degree requirements.

v) Courses like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc., shall be included in the curriculum as non-credit mandatory courses. Environmental Sciences is to be offered compulsorily as mandatory course for all branches. A student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

vi) Credit Definition:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit
2 Hours Practical (Lab) per week	1 Credit

(b) Award of B. Tech. (Honor)/B. Tech. (Minor): B. Tech. with Honors or a B. Tech. with a Minor will be awarded if the student earns 20 additional credits are acquired as per the regulations/guidelines. The regulations/guidelines are separately provided. Registering for Honors/Minor is optional.

8. Attendance Requirements

a) A student is eligible to write the University examinations if he acquires a minimum of 40% in each subject and 75% of attendance in aggregate of all the subjects.

b) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) may be granted by the College Academic Committee. However, this condonation concession is applicable only to any two semesters during the entire programme.

c) Shortage of Attendance below 65% in aggregate shall not be condoned.

d) A student who is short of attendance in a semester may seek re-admission into that semester when offered within 4 weeks from the date of commencement of class work.

e) Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.

f) A stipulated fee of Rs. 500/- in the concerned semester shall be payable towards condonation of shortage of attendance. Students availing condonation on medical ground shall produce a medical certificate issued by the competitive authority.
g) A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.
h) If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.
i) For induction programme attendance shall be maintained as per AICTE norms.
j) For non-credit mandatory courses the students shall maintain the attendance similar to credit courses

9. Evaluation-Distribution and Weightage of marks

(i) Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the University Examination section from time to time.

(ii) For non-credit mandatory courses, like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge, the student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

(iii) A student is deemed to have satisfied the minimum academic requirements if he has earned the credits allotted to each theory/practical design/drawing subject/ project etc by securing not less than 35% of marks in the end semester exam and minimum 40% of marks in the sum total of the internal marks and end semester examination marks together.

(iv) Distribution and Weightage of marks:

The assessment of the student's performance in each course will be based on Continuous Internal Evaluation (CIE) and Semester-End Examination (SEE). The performance of a student in each semester shall be evaluated subject–wise with a maximum of 100 marks for theory subject and 50 marks for practical subject. For theory subjects the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End Examinations.

S. No	Components	Internal	External	Total
1	Theory	30	70	100
2	Engineering Graphics/Design/Drawing	30	70	100
3	Practical	15	35	50
4	Mini Project/Internship/Industrial Training/ Skill Development programmes/Research Project	-	50	50
5	Project Work	60	140	200

(v) Continuous Internal Theory Evaluation:

(a) For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one online objective examination (ii) one descriptive examination and (iii) one assignment. The online examination (objective) shall be 10 marks and descriptive examination shall be for 15 marks with a total duration of 1 hour 50 minutes (20 minutes for objective and 90 minutes for descriptive paper).

(b) The first online examination (objective) is set with 20 multiple choice questions for 10 marks (20 questions x ½ marks) from first two and half units (50% of the syllabus) and it is conducted by **University Examination Section.** The descriptive examination is set with 3 full questions for 5 marks each from first two and half units (50% of the syllabus), the student has to answer all questions. In the similar lines, the second online and descriptive examinations shall be conducted on the rest of the syllabus.

(c) The assignment is given by the concerned class teacher for five marks from first two and half units (50% of the syllabus). The second assignment shall be given from rest of the syllabus. The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination.

(d) The total marks secured by the student in each mid-term examination are evaluated for 30 marks. The first mid marks (Mid-1) consisting of marks of online objective examination, descriptive

examination and assignment shall be submitted to the University examination section within one week after completion of first mid examination.

(e) The mid marks submitted to the University examination section shall be displayed in the concerned college notice boards for the benefit of the students.

(f) If any discrepancy found in the submitted Mid-1 marks, it shall be brought to the notice of university examination section within one week from the submission.

(g) Second mid marks (Mid-2) consisting of marks of online objective examination, descriptive examination and assignment shall also be submitted to University examination section within one week after completion of second mid examination and it shall be displayed in the notice boards. If any discrepancy found in the submitted mid-2 marks, it shall be brought to the notice of university examination section within one week from the submission.

(h) Internal marks can be calculated with 80% weightage for better of the two mids and 20% Weightage for another mid exam.

Example:

Mid-1 marks = Marks secured in (online examination-1+descriptive examination-1 +one assignment-1)

Mid-2 marks = Marks secured in (online examination-2+descriptive examination-2 +one assignment-2)

Final internal Marks = (Best of (Mid-1/Mid-2) marks x 0.8 + Least of (Mid-1/Mid-2) marks x 0.2)

(i) With the above criteria, university examination section will send mid marks of all subjects in consolidated form to all the concerned colleges and same shall be displayed in the concerned college notice boards. If any discrepancy found, it shall be brought to the notice of university examination section through proper channel within one week with all proofs. Discrepancies brought after the given deadline will not be entertained under any circumstances.

(vi) **Semester End Theory Examinations Evaluation:**

(a) The semester end examinations will be conducted university examination section for 70 marks consists of five questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

(b) For practical subjects there shall be continuous evaluation during the semester for 15 internal marks and 35 end examination marks. The internal 15 marks shall be awarded as follows: day to day work - 5 marks, Record-5 marks and the remaining 5 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the teacher concerned and external examiner appointed by controller of examinations, JNTUK.

Note: Laboratory marks and the internal marks awarded by the College are not final. The marks are subject to scrutiny and scaling by the University wherever felt desirable. The internal and laboratory marks awarded by the College will be referred to a Committee. The Committee shall arrive at a scaling factor and the marks will be scaled as per the scaling factor. The recommendations of the Committee are final and binding. All the laboratory records and internal test papers shall be preserved in respective departments as per University norms and shall be produced to the Committees of University as and when they ask for.

(c) For the subject having design and / or drawing (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (15 marks for continuous Assessment (day–to–day work) and 15 marks for internal tests) and 70 marks for end examination. There shall be two internal tests in a Semester for 15 marks each and final marks can be calculated with 80% weightage for better of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day-to-day work.

(d) Evaluation of the summer internships: It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs in the area of concerned specialization of the UG

programme. Students shall pursue this internship during summer vacation just before its offering as per course structure. The minimum duration of this course shall be at least 6 weeks. The student shall register for the internship as per course structure after commencement of academic year. A supervisor/mentor/advisor has to be allotted to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. Attendance requirements are as per the norms of the University. After successful completion, students shall submit a summer internship technical report to the concerned department and appear for an oral presentation before the departmental committee consists of an external examiner appointed by the University; Head of the Department, supervisor of the internship and a senior faculty member of the department. A certificate from industry/skill development center shall be included in the report. The report and the oral presentation shall carry 40% and 60% weightages respectively. It shall be evaluated for 50 external marks at the end of the semester. There shall be no internal marks for Summer Internship. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the University.

(e) The job-oriented skill courses may be registered at the college or at any accredited external agency. A student shall submit a record/report on the on the list skills learned. If the student completes job-oriented skill course at external agency, a certificate from the agency shall be included in the report. The course will be evaluated at the end of the semester for 50 marks (record: 15 marks and viva-voce: 35 marks) along with laboratory end examinations in the presence of external (appointed by the university) and internal examiner (course instructor or mentor). There are no internal marks for the job-oriented skill courses.

(f) Mandatory Course (M.C): Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc non-credit (zero credits) mandatory courses. Environmental Sciences shall be offered compulsorily as mandatory course for all branches. A minimum of 75% attendance is mandatory in these subjects. There shall be an external examination for 70 marks and it shall be conducted by the college internally. Two internal examinations shall be conducted for 30 marks and a student has to secure at least 40% of the marks for passing the course. There is no online internal exam for mandatory courses. No marks or letter grade shall be printed in the transcripts for all mandatory non-credit courses, but only Completed (Y)/Not-completed (N) will be specified.

(g) **Procedure for Conduct and Evaluation of MOOC:** There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL through online with the approval of Head of the Department. The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal. During the course, the mentor monitors the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed.

(h) *Major Project (*Project - Project work, seminar and internship in industry):

In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner.

Evaluation: The total marks for project work 200 marks and distribution shall be 60 marks for internal and 140 marks for external evaluation. The supervisor assesses the student for 30 marks (Report: 15 marks, Seminar: 15 marks). At the end of the semester, all projects shall be showcased at the department for the benefit of all students and staff and the same is to be

evaluated by the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the University and is evaluated for 140 marks.

10. Recounting of Marks in the End Semester Examination: A student can request for recounting of his/her answer book on payment of a prescribed fee as per university norms.

11. Re-evaluation or Revaluation by Challenge of the End Semester Examination: A student can request for Revaluation or Revaluation by Challenge of his/her answer book on payment of a prescribed fee as per university norms.

12. Supplementary Examinations: A student who has failed to secure the required credits can appear for a supplementary examination, as per the schedule announced by the University.

13. Malpractices in Examinations: Disciplinary action shall be taken in case of malpractices during Mid/End examinations as per the rules framed by the University.

14. Promotion Rules

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.8 for promotion to higher classes

a) A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement as per University norm.

b) A student will be promoted from II to III year if he fulfills the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.

a) A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

15. Course Pattern

a) The entire course of study is for four academic years; all years are on semester pattern.

b) A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.

c) When a student is detained for lack of credits/shortage of attendance, he may be re-admitted into the same semester/year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

16. Earning of Credit:

A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range A+ to E as given below. Letter grade 'F' in any course implies failure of the student in that course and no credits earned. Absent is also treated as no credits earned. For project same % percentages will be followed for grading.

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 50)	Level	Letter Grade	Grade Point
≥ 90	≥ 45	Outstanding	A+	10
≥80 to <89	≥40 to <44	Excellent	A	9
≥70 to <79	≥35 to <39	Very Good	B	8
≥60 to <69	≥30 to <34	Good	C	7
≥50 to <59	≥25 to <29	Fair	D	6
≥40 to <49	≥20 to <24	Satisfactory	E	5
<40	<20	Fail	F	0
-		Absent	AB	0

17. Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

(i) ***SGPA***(S_k) of k^{th} semester (1 to 8) is ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the total number of credits of all the courses undergone/registered by a student, i.e.,

$$SGPA(S_k) = \frac{\sum_{i=1}^{n}(C_i \times G_i)}{\sum_{i=1}^{n} C_i}$$

Where C_i is the number of credits of the i^{th} course/subject in a semester and G_i is the grade point scored by the student in the i^{th} course/subject and n is the number of courses/subjects registered in that semester.

(ii) CGPA: The CGPA is calculated in the same manner taking into account all the '*m'* courses/subjects registered by student over all the semesters of a Programme i.e., in all eight semesters

$$CGPA = \frac{\sum_{i=1}^{m}(C_i \times S_i)}{\sum_{i=1}^{m} C_i}$$

Where S_i is SGPA of the i^{th} semester and C_i is total number of credits in that semester.

(iii) SGPA and CGPA shall be rounded off to 2 decimal points and reported in transcripts.

(iv) While computing the SGPA/CGPA, the subjects in which the student is awarded Zero grade points will also be included.

(v) *Grade Point:* It is a numerical weight allotted to each letter grade on a 10-point scale.

(vi) *Letter Grade:* It is an index of the performance of students in a said course. Grades are denoted by letters A+, A, B, C, D, E, F and AB.

(vii) As per AICTE regulations, conversion of CGPA into equivalent percentage as follows:

Equivalent Percentage = (CGPA – 0.75) x 10

(viii) Illustration of Computation of SGPA and CGPA

Illustration for **SGPA:** Let us assume there are 6 subjects in a semester. The grades obtained as follows:

Course	Credit	Grade Obtained	Grade point	S_i= Credit Point (Credit x Grade)
Subject 1	3	B	8	3 X 8 = 24
Subject 2	4	C	7	4 X 7 = 28
Subject 3	3	D	6	3 X 6 = 18
Subject 4	3	A+	10	3 X 10 = 30
Subject 5	3	E	5	3 X 5 = 15
Subject 6	4	D	6	4 X 6 = 24
	20			139

Thus, **SGPA =139/20 =6.95=6.9 (approx.)**

Illustration for **CGPA:**

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credits: 20 SGPA: 6.9	Credits: 22 SGPA: 7.8	Credits: 25 SGPA: 5.6	Credits: 26 SGPA: 6.0
Semester 5	**Semester 6**	**Semester 7**	**Semester 8**

Credits: 26 SGPA: 6.3	Credits: 25 SGPA: 8.0	Credits: 21 SGPA: 6.4	Credits: 23 SGPA: 7.5

Thus,

$$CGPA = \frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0 + 21 \times 6.4 + 23 \times 7.5}{188} = \frac{1276.3}{188} = 6.78$$

18. Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 160 Credits
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

19. Minimum Instruction Days

The minimum instruction days for each semester shall be 90 working days. There shall be no branch transfers after the completion of the admission process. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

20. Withholding of Results

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

21. Transitory Regulations

(a) Discontinued or detained candidates are eligible for re-admission as and when next offered.

(b) The re-admitted candidate will be governed by the rules & regulations under which the candidate has been admitted.

(c) (i) In case of transferred students from other Universities, credits shall be transferred to JNTUK as per the academic regulations and course structure of JNTUK.

(ii) The students seeking transfer to colleges affiliated to JNTUK from various other Universities / Institutions have to obtain the credits of any equivalent subjects as prescribed by JNTUK. In addition, the transferred candidates have to pass the failed subjects at the earlier Institute with already obtained internal/sessional marks to be conducted by JNTUK.

22. Gap - Year

Gap Year concept of Student Entrepreneur in Residence shall be introduced and outstanding students who wish to pursue entrepreneurship are allowed to take a break of one year at any time after I/II/III year to pursue entrepreneurship full time. This period shall be counted for the maximum time for graduation. An evaluation committee at university level shall be constituted to evaluate the proposal submitted by the student and the committee shall decide on permitting the student for availing the Gap Year.

23. General

(a) Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

(b) The academic regulation should be read as a whole for the purpose of any interpretation.

(c) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

(d) The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

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ACADEMIC REGULATIONS (R20) FOR B. TECH (LATERAL ENTRY SCHEME)

Applicable for students admitted into II B. Tech. from the Academic Year 2020-21 onwards

1 **Award of B. Tech. Degree**

A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

a) A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years. After six academic years from the year of their admission, he/she shall **forfeit** their seat in B. Tech course and their admission stands cancelled.

b) The candidate shall register for 121 credits and secure all the 121 credits.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech (lateral entry).

3. **Promotion Rule**

A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.

A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**

After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 121 Credits from II Year to IV Year
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

5. All the other regulations as applicable to **B. Tech. 4-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme)**.

COMMUNITY SERVICE PROJECT

Introduction

1. Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
2. Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
3. Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

1. To sensitize the students to the living conditions of the people who are around them,
2. To help students to realize the stark realities of the society.
3. To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
4. To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
5. To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
6. To help students to initiate developmental activities in the community in coordination with public and government authorities.
7. To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project

1. Every student should put in a minimum of **180 hours** for the Community Service Project during the summer vacation.
2. Each class/section should be assigned with a mentor.
3. Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc
4. A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.
5. The log book has to be countersigned by the concerned mentor/faculty in charge.
6. Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
7. The final evaluation to be reflected in the grade memo of the student.
8. The Community Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.
9. Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
10. Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

Procedure

1. A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.
2. The Community Service Project is a twofold one –
   a) First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
   b) Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –

- Agriculture
- Health
- Marketing and Cooperation
- Animal Husbandry
- Horticulture
- Fisheries
- Sericulture
- Revenue and Survey
- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy
- Internet
- Free Electricity
- Drinking Water

EXPECTED OUTCOMES

BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS

Learning Outcomes

1. Positive impact on students' academic learning
2. Improves students' ability to apply what they have learned in "the real world"
3. Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development
4. Improved ability to understand complexity and ambiguity

Personal Outcomes

1. Greater sense of personal efficacy, personal identity, spiritual growth, and moral development
2. Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

1. Reduced stereotypes and greater inter-cultural understanding
2. Improved social responsibility and citizenship skills
3. Greater involvement in community service after graduation

Career Development

1. Connections with professionals and community members for learning and career opportunities

2. Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

1. Stronger relationships with faculty
2. Greater satisfaction with college
3. Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

1. Satisfaction with the quality of student learning
2. New avenues for research and publication via new relationships between faculty and community
3. Providing networking opportunities with engaged faculty in other disciplines or institutions
4. A stronger commitment to one's research

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

1. Improved institutional commitment
2. Improved student retention
3. Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

1. Satisfaction with student participation
2. Valuable human resources needed to achieve community goals
3. New energy, enthusiasm and perspectives applied to community work
4. Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT

The following the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programmes
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries
12. Animals and species
13. Nutrition
14. Traditional health care methods
15. Food habits
16. Air pollution
17. Water pollution
18. Plantation
19. Soil protection

20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice
23. Health care awareness programmes and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture
28. Access to safe drinking water
29. Geographical survey
30. Geological survey
31. Sericulture
32. Study of species
33. Food adulteration
34. Incidence of Diabetes and other chronic diseases
35. Human genetics
36. Blood groups and blood levels
37. Internet Usage in Villages
38. Android Phone usage by different people
39. Utilization of free electricity to farmers and related issues
40. Gender ration in schooling level- observation.

Complimenting the community service project, the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programmes are;

Programmes for School Children

1. Reading Skill Programme (Reading Competition)
2. Preparation of Study Materials for the next class.
3. Personality / Leadership Development
4. Career Guidance for X class students
5. Screening Documentary and other educational films
6. Awareness Programme on Good Touch and Bad Touch (Sexual abuse)
7. Awareness Programme on Socially relevant themes.

Programmes for Women Empowerment

1. Government Guidelines and Policy Guidelines
2. Womens' Rights
3. Domestic Violence
4. Prevention and Control of Cancer
5. Promotion of Social Entrepreneurship

General Camps

1. General Medical camps
2. Eye Camps
3. Dental Camps
4. Importance of protected drinking water
5. ODF awareness camp
6. Swatch Bharat
7. AIDS awareness camp
8. Anti Plastic Awareness
9. Programmes on Environment
10. Health and Hygiene
11. Hand wash programmes
12. Commemoration and Celebration of important days

Programmes for Youth Empowerment

1. Leadership
2. Anti-alcoholism and Drug addiction
3. Anti-tobacco
4. Awareness on Competitive Examinations
5. Personality Development

Common Programmes

1. Awareness on RTI
2. Health intervention programmes
3. Yoga
4. Tree plantation
5. Programmes in consonance with the Govt. Departments like –
    i. Agriculture
    ii. Health
    iii. Marketing and Cooperation
    iv. Animal Husbandry
    v. Horticulture
    vi. Fisheries
    vii. Sericulture
    viii. Revenue and Survey
    ix. Natural Disaster Management
    x. Irrigation
    xi. Law & Order
    xii. Excise and Prohibition
    xiii. Mines and Geology
    xiv. Energy

Role of Students:

1. Students may not have the expertise to conduct all the programmes on their own. The students then can play a facilitator role.
2. For conducting special camps like Health related, they will be coordinating with the Governmental agencies.
3. As and when required the College faculty themselves act as Resource Persons.
4. Students can work in close association with Non-Governmental Organizations like Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.
5. And also, with the Governmental Departments. If the programme is rolled out, the District Administration could be roped in for the successful deployment of the programme.
6. An in-house training and induction programme could be arranged for the faculty and participating students, to expose them to the methodology of Service Learning.

Timeline for the Community Service Project Activity

Duration: 8 weeks

1. **Preliminary Survey (One Week)**
    a) A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.
    b) A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.
    c) The Governmental agencies, like revenue administration, corporation and municipal authorities and village secretariats could be aligned for the survey.
2. ***Community Awareness Campaigns (Two Weeks)***

Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmes to be conducted, spread over two weeks of time. The list of activities suggested could be taken into consideration.

3. ***Community Immersion Programme (Four Weeks)***

Along with the Community Awareness Programmes, the student batch can also work with any one of the below listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to the experiential learning about the community and its dynamics. Programmes could be in consonance with the Govt. Departments.

4. ***Community Exit Report (One Week)***

During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks works to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that particular habitation. The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the University.

Throughout the Community Service Project, a daily log-book need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

	other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7.	Leaves the exam hall taking away answer script or intentionally tears the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action and impose suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show because notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student.

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. **Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.**
2. **Ragging entails heavy fines and/or imprisonment.**
3. **Ragging invokes suspension and dismissal from the College.**
4. **Outsiders are prohibited from entering the College and Hostel without permission.**
5. **Girl students must be in their hostel rooms by 7.00 p.m.**
6. **All the students must carry their Identity Cards and show them when demanded**
7. **The Principal and the Wardens may visit the Hostels and inspect the rooms any time.**

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

ACADEMIC REGULATIONS

COURSE STRUCTURE & DETAILED SYLLABUS

For

B.Tech FOUR YEAR DEGREE COURSE

(Applicable for the batches admitted from 2016-17)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533003, ANDHRA PRADESH, INDIA.

ACADEMIC REGULATIONS (R16) FOR B. TECH. (REGULAR)

Applicable for the students of B. Tech. (Regular) from the Academic Year 2016-17 onwards

1. **Award of B. Tech. Degree**

   A student will be declared eligible for the award of B. Tech. Degree if he fulfils the following academic regulations:

   1. A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years
   2. The candidate shall register for 180 credits and secure all the 180 credits.

2. **Courses of study**

   The following courses of study are offered at present as specializations for the B. Tech. Courses with English as medium of Instruction.

S. No	Branch
01	Civil Engineering
02	Electrical and Electronics Engineering
03	Mechanical Engineering
04	Electronics and Communication Engineering
05	Computer Science and Engineering
06	Information Technology
07	Petro Chemical Engineering
08	Chemical Engineering
09	Electronics and Instrumentation Engineering
10	Aeronautical Engineering
11	Automobile Engineering
12	Bio Technology
13	Electronics and Computer Engineering
14	Mining Engineering
15	Petroleum Engineering
16	Metallurgical Engineering
17	Agricultural Engineering

3. **Distribution and Weightage of Marks**

(i) The performance of a student in each semester shall be evaluated subject – wise with a maximum of 100 marks for theory subject and 75 marks for practical subject. The project work shall be evaluated for 200 marks.

(ii) For theory subjects the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End - Examinations.

(iii) For theory subjects, during the semester there shall be 2 tests. The weightage of Internal marks for 30 consists of Descriptive – 15, Assignment - 05 (Theory, Design, Analysis, Simulation, Algorithms, Drawing, etc. as the case may be and for Physics, Virtual Labs to be considered as Assignments) Objective -10 (Conducted at College level with 20 Multiple choice question with a weightage of ½ Mark each). The objective examination is for 20 minutes duration. The subjective examination is for 90 minutes duration conducted for 15 marks. Each subjective type test question paper shall contain **3 questions** and all questions need to be answered. The Objective examination conducted for 10 marks and subjective examination conducted for 15 marks are to be added to the assignment marks of 5 for finalizing internal marks for 30.

Internal Marks can be calculated with 80% weightage for best of the two Mids and 20% weightage for other Mid Exam As the syllabus is framed for 6 units, the 1st mid examination (both Objective and Subjective) is conducted in 1-3 units and second test in 4-6 units of each subject in a semester.

(iv) The end semester examination is conducted covering the topics of all Units for 70 marks. End Exam Paper: Part-A 1st Question is mandatory covering all the syllabus which contains seven 2 marks questions for 14 marks with atleast 2 marks of question for each of the six units and in Part-B 4 Questions out of 6 Questions are to be answered with each carrying 14 marks . Part-A & Part-B put together gives for 70 marks.

(v) For practical subjects there shall be continuous evaluation during the semester for 25 internal marks and 50 end examination marks. The internal 25 marks shall be awarded as follows: day to day work - 10 marks, Record-5 marks and the remaining 10 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the teacher concerned and external examiner.

(vi) For the subject having design and / or drawing, (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (20 marks for day – to – day work, and 10 marks for internal tests) and 70 marks for end examination. There shall be two internal tests in a Semester and the Marks for 10 can be calculated with 80% weightage for best of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day to day work.

(vii) For the seminar, Each student has to be evaluated based on the presentation of any latest topic with report of 10-15 pages and a ppt of min 10 slides. The student shall collect the information on a specialized topic and prepare a technical report, showing his understanding over the topic, and submit to the department, which shall be evaluated by the Departmental committee consisting of Head of the department, seminar supervisor and a senior faculty member. The seminar report shall be evaluated for 50 marks. There shall be no external examination for seminar.

(viii) Out of a total of 200 marks for the project work, 60 marks shall be for Internal Evaluation and 140 marks for the End Semester Examination. The End Semester Examination (Viva – Voce) shall be conducted by the committee. The committee consists of an external examiner, Head of the Department and Supervisor of the Project. The evaluation of project work shall be conducted at the end of the IV year. The Internal Evaluation shall be on the basis of two seminars given by each student on the topic of his project and evaluated by an internal committee.

(ix) Laboratory marks and the internal marks awarded by the College are not final. The marks are subject to scrutiny and scaling by the University wherever felt desirable. The internal and laboratory marks awarded by the College will be referred to a Committee. The Committee shall arrive at a scaling factor and the marks will be scaled as per the scaling factor. The recommendations of the Committee are final and binding. The laboratory records and internal test papers shall be preserved in the respective departments as per the University norms and shall be produced to the Committees of the University as and when they ask for.

4. **Attendance Requirements**

1. A student is eligible to write the University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.
2. Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee
3. Shortage of Attendance below 65% in aggregate shall not be condoned.
4. A student who is short of attendance in semester may seek re-admission into that semester when offered within 4 weeks from the date of the commencement of class work.
5. Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.
6. A stipulated fee shall be payable towards condonation of shortage of attendance.
7. A student will be promoted to the next semester if he satisfies the (i)attendance requirement of the present semester and (ii) minimum required credits.
8. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

5. **Minimum Academic Requirements**

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.4.

5.1 A student is deemed to have satisfied the minimum academic requirements if he has **earned the credits allotted to each theory/practical design/drawing subject/project by securing not less than 35% of marks in the end semester exam, and minimum 40% of marks in the sum total of the internal marks and end semester examination marks.**

5.2 A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement.

5.3 A student will be **promoted from II year to III year** if he fulfills the academic requirement **of 40% of the credits up to either II year I semester or II year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.**

5.4 A student shall be **promoted from III year to IV year** if he fulfils the academic requirements of **40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.**

5.5 A student shall register and put up minimum attendance in all 180 credits and earn all 180 credits.

6. Course Pattern

1. The entire course of study is for four academic years, all the years are on semester pattern.
2. A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.
3. When a student is detained for lack of credits / shortage of attendance, he may be re-admitted into the same semester / year in which he has been detained. However, the academic regulations under which he was first admitted shall continues to be applicable to him.

7. CGPA

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 75)	Letter Grade	Level	Grade Point
≥ 90	≥ 67	O	Outstanding	10
≥80 to <90	≥60 to <67	S	Excellent	9
≥70 to <80	≥52 to <60	A	Very Good	8
≥60 to <70	≥45 to <52	B	Good	7
≥50 to <60	≥37 to <45	C	Fair	6
≥40 to <50	≥30 to <37	D	Satisfactory	5
<40	<30	F	Fail	0
			Absent	0

Computation of SGPA

The following procedure is to be adopted to compute the Semester Grade Point Averagae. (SGPA) and Cumulative Grade Point Average (CGPA):

The **SGPA** is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = $\sum$ (Ci X Gi) / $\sum$ Ci

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Computation of CGPA

- The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a programme, i.e.

  CGPA = ∑ (Ci X Si) / ∑ Ci

  Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.

- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

- Equivalent Percentage = (CGPA – 0.75) x 10

8. Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	**CGPA to be secured**	
First Class with Distinction	≥ 7.75 with no subject failures	**From the CGPA secured from 180 Credits.**
First Class	≥ 6.75 with subject failures	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

9. Minimum Instruction Days

The minimum instruction days for each semester shall be 90 working days.

10. There shall be no branch transfers after the completion of the admission process.
11. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

12. **Withholding of Results**

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

13. **Transitory Regulations**

1. Discontinued or detained candidates are eligible for readmission as and when next offered.
2. The readmitted students will be governed by the regulations under which the candidate has been admitted.
3. (a) In case of transferred students from other Universities, the credits shall be transferred to JNTUK as per the academic regulations and course structure of the JNTUK**.**

(b) The students seeking transfer to colleges affiliated to JNTUK from various other Universities / Institutions have to obtain the credits of any equivalent subjects as prescribed by JNTUK. In addition, the transferred candidates have to pass the failed subjects at the earlier instiute with already obtained sessional marks to be conducted by JNTUK.

14. General

1. Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.
2. The academic regulation should be read as a whole for the purpose of any interpretation.
3. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
4. The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

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ACADEMIC REGULATIONS (R16) FOR B. TECH. (LATERAL ENTRY SCHEME)

Applicable for the students admitted into II year B. Tech. from the Academic Year 2017-18 onwards

1 **Award of B. Tech. Degree**

A student will be declared eligible for the award of B. Tech. Degree if he fulfils the following academic regulations:

1.1 A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years.

1.2 The candidate shall register for 132 credits and secure all the 132 credits.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech.

3. **Promotion Rule**

A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.

A student shall be promoted from III year to IV year if he fulfils the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**

After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	**CGPA to be secured**	**From the CGPA secured from 132 Credits from II Year to IV Year**
First Class with Distinction	≥ 7.75 with no subject failures	
First Class	≥ 6.75 with subject failures	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

The marks obtained in the internal evaluation and the end semester examination shall be shown separately in the marks memorandum.

5. All the other regulations as applicable to **B. Tech. 4-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme)**.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the

	examination.	remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA-533003, Andhra Pradesh (India)
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing and Humiliation	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

KAKINADA-533003, Andhra Pradesh (India)
For Constituent Colleges and Affiliated Colleges of JNTUK
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Cards and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
(Established by Andhra Pradesh Act No.30 of 2008)

Kakinada – 533 003, Andhra Pradesh (India)

ACADEMIC REGULATIONS R19 FOR M. Tech (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech (Regular) Course from the Academic Year 2019-20 onwards. The M. Tech Degree of Jawaharlal Nehru Technological University Kakinada shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M. Tech DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech Degree, if he pursues a course of study in not less than two and not more than four academic years.

2.2 **The student shall register for all 68 credits and secure all the 68 credits.**

2.3 The minimum instruction days in each semester are 90.

3.0 PROGRAMME OF STUDY

The following specializations are offered at present for the M. Tech Programme of study.

M.Tech

1. M.Tech- Structural Engineering
2. M.Tech- Structural Design
3. M. Tech- Transportation Engineering
4. M.Tech- Infrastructure Engineering & Management
5. M. Tech - Computer Aided Structural Engineering
6. M. Tech - Soil Mechanics and Foundation Engineering
7. M. Tech- Environmental Engineering
8. M.Tech-Geo-Informatics
9. M.Tech-Spatial Information Technology

10. M.Tech- Civil Engineering
11. M. Tech-Highway Engineering
12. M.Tech -Geo-Technical Engineering
13. M.Tech- Remote Sensing
11. M.Tech- Power Electronics
12. M.Tech- Power & Industrial Drives
13. M.Tech- Power Electronics & Electrical Drives
14. M.Tech- Power System Control & Automation
15. M.Tech- Power Electronics & Drives
16. M.Tech- Power Systems
17. M.Tech- Power Systems Engineering
18. M.Tech- Electrical Power Systems
19. M.Tech- High Voltage Engineering
20. M.Tech- Power Electronics and Power Systems
21. M.Tech- Power System and Control
22. M.Tech- Power Electronics & Systems
23. M.Tech- Electrical Machines and Drives
24. M.Tech- Advanced Power Systems
25. M.Tech- Power Systems with Emphasis on High Voltage Engineering
26. M.Tech- Control Engineering
27. M.Tech- Control Systems
28. M.Tech- Electrical Power Engineering
29. M.Tech- Power Engineering & Energy System
29. M.Tech- Thermal Engineering
30. M.Tech- CAD/CAM
31. M.Tech- Machine Design
32. M.Tech- Computer Aided Design and Manufacture
33. M.Tech- Advanced Manufacturing Systems
34. M.Tech-Computer Aided Analysis & Design
35. M.Tech- Mechanical Engineering Design
36. M.Tech- Systems and Signal Processing
37. M.Tech- Digital Electronics and Communication Systems
38. M.Tech- Electronics & Communications Engineering
39. M.Tech- Communication Systems
40. M.Tech- Communication Engineering & Signal Processing
41. M.Tech- Microwave and Communication Engineering
42. M.Tech- Telematics
43. M.Tech- Digital Systems & Computer Electronics
44. M.Tech- Embedded System
45. M.Tech- VLSI
46. M.Tech- VLSI Design

47. M.Tech- VLSI System Design
48. M.Tech- Embedded System & VLSI Design
49. M.Tech- VLSI & Embedded System
50. M.Tech- VLSI Design & Embedded Systems
51. M.Tech- Image Processing
52. M.Tech- Digital Image Processing
53. M.Tech- Computers & Communication
54. M.Tech- Computers & Communication Engineering
55. M.Tech- Instrumentation & Control Systems
56. M.Tech – VLSI & Micro Electronics
57. M.Tech – Digital Electronics & Communication Engineering
58. M.Tech- Embedded System & VLSI
59. M.Tech- Computer Science & Engineering
60. M.Tech- Computer Science
61. M.Tech- Computer Science & Technology
62. M.Tech- Computer Networks
63. M.Tech- Computer Networks & Information Security
64. M.Tech- Information Technology
65. M.Tech- Software Engineering
66. M.Tech- Neural Networks
67. M.Tech- Chemical Engineering
68. M.Tech- Biotechnology
69. M.Tech- Nano Technology
70. M.Tech- Food Processing
71. M.Tech- Avionics
72. M. Tech- Mining Engineering
73. M. Tech- Auto mobile Engineering
74. M. Tech- Agricultural Engineering
75. M. Tech - Material Science and Technology

and any other course as approved by AICTE/ University from time to time.

3.0 B. <u>Departments offering M. Tech Programmes with specializations are noted below</u>:

Civil Engg.	1. M.Tech. - Structural Engineering 2. M.Tech. - Structural Design 3. M.Tech. - Computer Aided Structural Engineering 4. M.Tech - Infrastructure Engineering & Management 5. M.Tech - Civil Engineering 6. M. Tech - Soil Mechanics and Foundation Engineering 7. M.Tech - Geo-Technical Engineering 8. M.Tech - Transportation Engineering 9. M.Tech - Environmental Engineering

	10. M.Tech - Geo-Informatics 11. M. Tech-Highway Engineering
EEE	1. M.Tech- Power Electronics 2. M.Tech- Power & Industrial Drives 3. M.Tech- Power Electronics & Electrical Drives 4. M.Tech- Power System Control & Automation 5. M.Tech- Power Electronics & Drives 6. M.Tech- Power Systems 7. M.Tech- Power Systems Engineering 8. M.Tech- Electrical Power Systems 9. M.Tech- High Voltage Engineering 10. M.Tech- Power Electronics and Power Systems 11. M.Tech- Power System and Control 12. M.Tech- Power Electronics & Systems 13. M.Tech- Electrical Machines and Drives 14. M.Tech- Advanced Power Systems 15. M.Tech- Power Systems with Emphasis on High Voltage Engineering 16. M.Tech- Control Engineering 17. M.Tech- Control Systems 18. M.Tech- Electrical Power Engineering 19. M.Tech- Power Engineering & Energy System
ME	1. M.Tech- Thermal Engineering 2. M.Tech- CAD/CAM 3. M.Tech- Machine Design 4. M.Tech- Computer Aided Design and Manufacture 5. M.Tech- Advanced Manufacturing Systems 6. M.Tech-Computer Aided Analysis & Design 7. M.Tech- Mechanical Engineering Design 8. M.Tech- Mining Engineering 9. M. Tech- Automobile Engineering
ECE	1. M.Tech- Systems and Signal Processing 2. M.Tech- Digital Electronics and Communication Systems 3. M.Tech- Electronics & Communications Engineering 4. M.Tech- Communication Systems 5. M.Tech- Communication Engineering & Signal Processing 6. M.Tech- Microwave and Communication Engineering 7. M.Tech- Telematics 8. M.Tech- Digital Systems & Computer Electronics 9. M.Tech- Embedded System 10. M.Tech- VLSI 11. M.Tech- VLSI Design 12. M.Tech- VLSI System Design 13. M.Tech- Embedded System & VLSI Design

	14. M.Tech- VLSI & Embedded System 15. M.Tech- VLSI Design & Embedded Systems 16. M.Tech- Image Processing 17. M.Tech- Digital Image Processing 18. M.Tech- Computers & Communication 19. M.Tech- Computers & Communication Engineering 20. M.Tech- Instrumentation & Control Systems 21. M.Tech – VLSI & Micro Electronics 22. M.Tech – Digital Electronics & Communication Engineering 23. M.Tech- Embedded System & VLSI
CSE	1. M.Tech- Computer Science & Engineering 2. M.Tech- Computer Science 3. M.Tech- Computer Science & Technology 4. M.Tech- Computer Networks 5. M.Tech- Computer Networks & Information Security 6. M.Tech- Information Technology 7. M.Tech- Software Engineering 8. M.Tech- Neural Networks 9. M.Tech- Cyber Security 10. MCA
Metallurgical Engineering	1. M. Tech - Material Science and Technology
Inter disciplinary	2. M.Tech - Chemical Engineering 3. M.Tech – Bio-technology 4. M.Tech – Nano-Technology 5. M.Tech- Food Processing Technology 6. M.Tech- Avionics 7. M.Tech - Remote Sensing 8. M.Tech - Spatial Information Technology 9. M.Tech - Environmental Engineering & Management 10. M.Tech – Renewable Energy 11. M.Tech – Environmental Occupational Health & Safety 12. M.Tech - Agricultural Engineering
MBA	1. MBA Regular 2. Integrate MBA 3. MBA (Agribusiness Management/Entrepreneurship) 4. MBA (Master in Hospital Administration) 5. MBA (Logistics and Supply Chain Management) 6. Dual Degree MBA (Previously MAM)

4.0 ATTENDANCE

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects/courses, and with minimum 50% in each and every course including practicals.

4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.

4.3 Shortage of Attendance **below** 65% in aggregate shall not be condoned and not eligible to write their end semester examination of that class.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.

4.5 A prescribed fee shall be payable towards Condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless, he satisfies the attendance requirement of the present semester, as applicable. They may seek re-admission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for re-admission into the same class.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practical, on the basis of Internal Evaluation and End Semester Examination.

5.1 For the theory subjects 75 marks shall be awarded based on the performance in the End Semester Examination and 25 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the **average** of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with 4 questions (without choice) each question for 10 marks, and it will be reduced to 25 marks. End semester examination is conducted for 75 marks for all FIVE (5) questions (one question from one unit) to be answered (either or).

5.2 For practical subjects, 75 marks shall be awarded based on the performance in the End Semester Examinations and 25 marks shall be awarded based on the day-to-day performance as Internal Marks. The internal evaluation based on the day to day work-5 marks, record- 5 marks and the remaining 15 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the examiners, with a breakup marks of Procedure-20, Experimentation-30, Results-10, Viva-voce-15.

5.3 For Mini Project with Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Mini Project with Seminar, there will be only internal evaluation of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.5 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to re-appear for the End semester Examination in that subject. A candidate shall be given **one** chance to re-register for each subject provided the internal marks secured by a candidate **are less than 50% and has failed in the end examination.** In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt shall stands cancelled. For re-registration the candidates have to apply to the University through the college by paying the requisite fees and get approval from the University before the start of the semester in which re-registration is required.

5.6 In case the candidate secures less than the required attendance in any re-registered subject(s), he shall not be permitted to write the End Examination in that subject. He shall again re-register the subject when next offered.

5.7 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher or teacher of the respective college and the second examiner shall be appointed by the University from the panel of examiners submitted by the respective college.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members in the department.

6.2 Registration of Dissertation/Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the PRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.5 Continuous assessment of Dissertation-I and Dissertation-II during the Semester(s) will be monitored by the PRC.

6.6 A candidate shall submit his status report in two stages to the PRC, at least with a gap of 3 months between them.

6.7 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

6.8 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute.

6.9 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.10 If the report of the examiner is not favorable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

6.11 The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination.

6.12 If the report of the examiner is favorable, Viva - Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the Examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work for a maximum of 100 marks.

6.13 If the report of the Viva -Voce is unsatisfactory (i.e., <50 % of marks), the candidate shall retake the Viva-Voce examination, only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the University.

7.0 **Cumulative Grade Point Average (CGPA)**

Marks Range Theory/ Laboratory (Max – 100)	**Marks Range Mini Project/ Project Work or Dissertation (Max – 100)**	**Letter Grade**	**Level**	**Grade Point**
≥ 90	≥ 90	O	Excellent	10
≥80 to <90	≥80 to <90	S	Very Good	9
≥70 to <80	≥70 to <80	A	Good	8
≥60 to <70	≥60 to <70	B	Fair	7
≥50 to <60	≥50 to <60	C	Satisfactory	6
<50	<50	F	Fail	0
		AB	Absent	0

Computation of SGPA

- The following procedure is to be adopted to compute the Semester Grade Point Average(SGPA) and Cumulative Grade Point Average(CGPA):

- The **SGPA** is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

- **SGPA (Si) =** $\sum$ **(Ci X Gi) /** $\sum$ **Ci**

- Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Computation of CGPA

- The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a Programme, i.e.
- **CGPA =** $\sum$ **(Ci X Si) /** $\sum$ **Ci**
- Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- Equivalent Percentage = (CGPA – 0.75) x 10

8.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	**CGPA to be secured**	
First Class with Distinction	$\geq$ 7.75 (Without any supplementary appearance)	**From the CGPA secured from 68 Credits.**
First Class	$\geq$ 7.75 (With any supplementary appearance) $\geq$ 6.75 and < 7.75 (Without any supplementary appearance)	
Second Class	$\geq$ 6.75 and < 7.75 (With any supplementary appearance) $\geq$ 6.0 to < 6.75 (Without any supplementary appearance)	
Pass Class	$\geq$ 6.0 to < 6.75 (With any supplementary appearance)	

The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

9.0 WITHHOLDING OF RESULTS

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

10.0 TRANSITORY REGULATIONS (for R19)

10.1 Discontinued or detained candidates are eligible for readmission (within the duration as mentioned in item 2.1) as and when next offered.

10.2 The readmitted students will be governed by the regulations under which the candidate has been admitted.

11.0 GENERAL

11.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

11.2 The academic regulation should be read as a whole for the purpose of any interpretation.

11.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

11.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in	The candidate who has impersonated shall

	connection with the examination.	be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant –	In case of students of the college, they shall be expelled from examination halls and

	Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which	

	is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   (i) A show cause notice shall be issued to the college.
   (ii) Impose a suitable fine on the college.
   (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

Seminar/ comprehensive vivo evaluation

There shall be two seminar presentations during III semester and IV semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

(a) For Ist & IInd semesters Seminar 100 marks are allotted for each, which shall be awarded based on the performance of the student on the selected advanced topic which is subdivided as follows.

- Marks for assignment - 20
- Marks for Power Point Presentation - 60
- Marks for viva voce (Orals) - 20

Total marks - 100

(b) There shall be two seminar presentations during III semester and IV semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee (PRC) consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

M. Pharmacy

1. Pharmaceutical Analysis
2. Pharmaceutical Analysis & Q A
3. Pharmaceutical Analysis & QC
4. Pharmaceutical Chemistry
5. Pharmaceutical Management & Regulatory Affairs
6. Pharmaceutical Technology
7. Pharmaceutics
8. Pharmacognosy
9. Pharmacology
10. Pharmacology & Toxicology
11. Pharmacy Practices
12. Quality Assurance & Regulatory Affairs

ACADEMIC REGULATIONS & COURSE STRUCTURE

For

CONTROL SYSTEMS (CS)
CONTROL ENGINEERING (CE)

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Semester

S. No.	Subject	L	P	Credits
1	Advanced Control Theory	4	--	3
2	Advanced Digital Control Systems	4	--	3
3	Stochastic Estimation and Control	4	--	3
4	System and Parameter Identification	4	--	3
5	**Elective-I** i. Computer Controlled Systems ii. Control of Special Machines	4	--	3
6	**Elective-II** i. Micro Controllers& Applications ii. Process Control and Automation	4	--	3
7	Simulation Laboratory	--	4	2
Total Credits				**20**

II Semester

S. No.	Subject	L	P	Credits
1	Robotics and Control	4	--	3
2	Non-Linear Systems Analysis	4	--	3
3	Digital Signal Processing	4	--	3
4	Optimal Control Theory	4	--	3
5	**Elective-III** i. A I Techniques ii. Embedded Real Time Operating System EMS	4	--	3
6	**Elective-IV** i. Decision and Estimation Theory ii. Embedded Computer Control.	4	--	3
7	Advanced Control System Laboratory	--	4	2
Total Credits				**20**

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	**--**	**--**	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				**20**

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				**20**

I Year - I Semester

L	P	C
4	0	3

ADVANCED CONTROL THEORY

(Common to CS & CE)

Course Educational Objectives:

- To present state models in various forms.
- To learn the concept of controllability and observability of LTI systems.
- To discuss and learn the design concepts for feedback controller and observers.

UNIT I

Introductory matrix algebra and linear vector space, State space representation of systems.Linearization of a non - linear system.Solution of state equations. Evaluation of State Transition Matrix (STM) - Simulation of state equation using MATLAB/ SIMULINK program.

UNIT II

Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO, MISO transfer functions. Discretization of a continuous time state space model.Conversion of state space model to transfer function model using Fadeeva algorithm.

UNIT III

Fundamental theorem of feedback control - Controllability and Controllable canonical form - Pole assignment by state feedback using Ackermann's formula – Eigen structure assignment problem. Observability and observable canonical form

UNIT IV

Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using eigenvalue and eigen vector methods, iterative method. Controller design using output feedback.Internal stability of a system.Stability in the sense of Lyapunov, asymptotic stability of linear time invariant continuous and discrete time systems. Solution of Lyapunov type equation.

UNIT V

Duality between controllability and observability - Full order Observer based controller design. Reduced order observer design. Model decomposition and decoupling by state feedback. Disturbance rejection, sensitivity and complementary sensitivity functions. Design of full order observer using Ackermann's formula - Bass Gura algorithm.

Course Outcomes:

Aftercompletion ofthis coursethe students will be:

- Able to apply matrix algebra to develop various forms of state models.
- Able to develop and analyze physical systems.
- Able to analyze state models.
- Able to design state feedback controller and observer.

Reference Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997
2. T. Kailath, T., Linear Systems, Perntice Hall, Englewood Cliffs, NJ, 1980.
3. N. K. Sinha , Control Systems, New Age International, 3rd edition, 2005**.**
4. Panos J Antsaklis, and Anthony N. Michel, Linear Systems, New - age international (P) LTD. Publishers, 2009.
5. John J D'Azzo and C. H. Houpis , "Linear Control System Analysis and Design Conventional and Modern", McGraw - Hill Book Company, 1988.
6. B.N. Dutta, Numerical Methods for linear Control Systems - , Elsevier Publication, 2007.
7. C.T.Chen Linear System Theory and Design - PHI, India.
8. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 11th Edition, Pearson Edu, India, 2009.

I Year - I Semester

L	P	C
4	0	3

ADVANCED DIGITAL CONTROL SYSTEMS

(Common to CS & CE)

Course Educational Objectives:

- To familiarize mathematical analysis of digital control systems.
- To introduce state feedback controllers and observers for digital control systems.
- To understand state estimation and state observer design methodology of single output and multi output systems.

UNIT I

Overview of modern digital control theories, Z- and inverse Z-transformation and properties, Discrete-time systems and difference equations, Sampling and reconstruction (A/D and D/A conversions), Z- and S-plane correspondence and stability test, Analysis of sampled data systems.

UNIT II

Discrete-time state equations, Sampled continuous-time systems, Canonical forms, transformation to controllable, observable and diagonal forms, Controllability and observability.

UNIT III

State determination and control, State feedback and eigenvalue placement of single input systems, State feedback and eigenvalue placement of multi-Input systems, Quadratic optimal control, Digital tracking systems.

UNIT IV

State estimation, State observer design for single out-put systems, State observer design for multi-output systems, System Identification.

UNIT V

Digitizing analog controllers, Designing between-sample response, Digital hardware control, Actuators limitation.

Course Outcomes:

Aftercompletion ofthis coursethe students are able to:

- Analyze digital control theories using Z transform methods.
- Understand the stability criteria of discrete time systems.
- Obtain various state space models of discrete- time systems and verify controllability and observabilty.
- Design state observer for single output and multi output systems.
- Design digital hardware controller.

Reference Books:

1. Ms. Santina, A.R.Stuberud&G.H.Hostetter, Digital Control Systems Design, Oxford Univ Press, 2nd edition.
2. B.C Kuo, Digital Control Systems, 2nd Edition, Oxford Univ Press, Inc., 1992.
3. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison - Wesley Longman, Inc., Menlo Park, CA , 1998.
4. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, India, 1997.
5. C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill, 1985.
6. John S. Baey, Fundamentals of Linear State Space Systems, Mc. Graw – Hill, 1st edition
7. Bernard Fried Land, Control System Design, Mc. Graw – Hill, 1st edition
8. Dorsay, Continuous and Discrete Control Systems, McGraw - Hill.

I Year - I Semester

L	P	C
4	0	3

STOCHASTICESTIMATION AND CONTROL

(Common to CS & CE)

Course Educational Objectives:

- To formulate system models for continuous and discrete linear systems.
- To introduce the smooth estimation techniques for continuous and discrete linear systems.
- To understand various methods of optimal estimation for continuous linear systems.

UNIT I

Elements of the theory of stochastic processes, Gauss-Markov sequence model, Gauss- Markov process model.

UNIT II

Optimal estimation for discrete linear systems, optimal prediction of discrete linear systems, optimal filtering for discrete linear systems, optimal filtering in the presence of time-correlated disturbance and measurements.

UNIT III

Classification of smoothed estimates, single and double stage optimal smoothing, optimal fixed-interval smoothing, optimal fixed-point smoothing, optimal fixed-lag smoothing

UNIT IV

Stochastic optimal control for discrete linear systems: Problem formulation, Deterministic problem, stochastic problem

UNIT V

Optimal estimation for continuous linear systems: Problem formulation, equivalent Discrete-time problem, optimal filtering and prediction, optimal fixed-interval smoothing, optimal fixed-point smoothing, optimal fixed-lag smoothing.

Course Outcomes:

After completion of this course students are able to:

- Apply the knowledge of probability theory to stochastic control problems
- Develop optimal filters for process measurements.
- Analyze optimal estimation methods for continuous linear systems.

Reference Books:

1. Stochastic Optimal Linear Estimation and Control, J.S.Meditch, Tata McGraW Hill Book Company, 1969.
2. Optimal Control and Estimation, Robert F. Stengel, Dover Publications, Newyok, 1994.
3. A. Gelb, Applied Optimal Estimation, MIT Press.

I Year - I Semester

L	P	C
4	0	3

SYSTEM AND PARAMETER IDENTIFICATION

(Common to CS & CE)

Course Educational Objectives:

- To understand the identification of dynamic systems.
- To understand state and parameter estimation of linear systems.
- To identify non-linear state models.

UNIT I Introduction:
System models and model classification, Identification problem, some fields of applications.

UNIT-II Classical models:
Time response and frequency response methods of transfer function evolution, Impulse response identification using cross correlation test and orthogonal series expansion, methods of convolution, model learning technique.

UNIT-III Least square Method:
Least square estimates and its properties, non-recursive least square identification of dynamic system, extensions such as generalised least square repeated least square and instrumental variable method. Recurse Methods: Recursive least square, minimum variance algorithms, stochastic approximation method, maximum likelihood method.

UNIT IV Identification of state variable models:
State Estimatior using Kalman and extended kalman filter, simultaneous state and parameter estimation of linear systems.

UNIT V Non-Linear systems identification:
Identification of a volterra series models, identification of non-linear state models using extended kalman filter, quasilinearization method, invariant imbedding, gradient method, Numerical identification through model following approach.

Course Outcomes:
After completion of this course students are able to:

- Understand the identification problems.
- Develop state estimation using Kalman filters.
- Extend different mathematical models in identifiers non-linear systems.

Reference Books:

1. J.M.Mendel, 'Discrete Techniques Of Parameter Esimation', Marcel Dekker, 1973.
2. F.Eykhoff, 'System Identification, Parameter and State Estimation, John Willey, 1974.
3. A.P.Sage and J.L.Melsa'System Identification',Academic press, 1971.

I Year - I Semester

L	P	C
4	0	3

COMPUTER CONTROLLED SYSTEMS

(Common to CS & CE)

(Elective-I)

Course Educational Objectives:

- To introduce basic concepts of multi variable control and real time systems.
- To understand the concept PLCS, SCADA & distributed control systems.
- To understand the concepts of real time systems and their architecture.

UNIT I

Multivariable control:Basic expressions for MIMO systems, Singular values, Stability norms, Calculation of system norms, Robustness, Robust stability. H^2 / H^∞ Theory: Solution for design using H^2 / H^∞ , Case studies, Interaction and decoupling, Relative gain analysis, Effects of interaction, Response to disturbances, Decoupling, Introduction to batch process control.

UNIT II

Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system

UNIT III

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules. PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

UNIT IV

SCADA: Introduction, SCADA Architecture, Different Communication Protocols, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Trends in SCADA, Security Issues

UNIT V

Real time systems- Real time specifications and design techniques- Real time kernels- Inter task communication and synchronization- Real time memory management- Supervisory control- direct digital control- Distributed control- PC based automation.

Course Outcomes:

Aftercompletion ofthis course students are able to:

- Understand Multi variable control systems.
- Design optimal controller using H2 / H∞.
- Develop SCADA Architecture for a specific application.

Reference Books:

1. Shinskey F.G., Process control systems: application , Design and Tuning, McGraw Hill International Edition ,Singapore,1988.
2. Be.langer P.R. , Control Engineering: A Modern Approach, Saunders College Publishing , USA, 1995.
3. Dorf, R.C. and Bishop R. T. , Modern Control Systems , Addison Wesley Longman Inc., 1999
4. Laplante P.A., Real Time Systems: An Engineer.s Handbook, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
5. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications,USA,1999
6. EfimRosenwasser, Bernhard P. Lampe, Multivariable computer-controlled systems: a transfer function approach, Springer, 2006
7. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
8. Programmable Logic Controllers – Programming Method and Applications by JR.Hackworth and F.D Hackworth Jr. – Pearson, 2004.

CONTROL OF SPECIAL MACHINES

(Common to CS & CE)

(Elective-I)

Course Educational Objectives:

- To introduce with Special type of electrical machines.
- To draw the characteristics of special type electrical machines.
- To understand the different control schemes of special machines.

UNIT I

Stepper Motors:Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor. Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

UNIT II

Switched Reluctance Motors: Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, DriveConcept. Permanent Magnet Synchronous Motors: Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power Controllers, Torque speed characteristics, Self-control, Vector control, Current control Schemes.

UNIT III

Permanent Magnet Brushless DC Motors: Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessors based controller.

UNIT IV

Servomotors: Types, Constructional features, Principle of Operation, Characteristics, Control,– Microprocessor based applications. AC Tachometers: Schematic diagram, Operating principle, numerical problems

UNIT V

Linear Motors: Linear Induction Motor (LIM) Classification, Construction, Principle of operation, Concept of Current sheet, Goodness factor, DC Linear Motor (DCLM) types, Circuit equation, DCLM control, applications.

Course Outcomes:

Aftercompletion ofthis course students are able to:

- Analyze the characteristics of different types of PM type Brushless DC motors and to design suitable controllers
- Apply the knowledge of sensors used in PMSM which can be used for controllers and synchronous machines.
- Evaluate the steady state and transient behavior Linear induction motors
- Analyze the different controllers used in electrical machines to propose the suitability of drives for different industrial applications
- Classify the types of DC Linear motors and apply the knowledge of controllers to propose their applications in real world.
- Able to understand different special electrical machines.
- Able to understand speed control schemes.

Reference Books:

1. Miller, T.J.E. “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press,Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987.
4. Floyd E Saner,”Servo Motor Applications”, Pittman USA, 1993.
5. Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors”, Clarendon Press, Oxford, 1989.
6. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995.

I Year - I Semester

L	P	C
4	0	3

MICRO CONTROLLERS& APPLICATIONS

(Common to CS & CE)

(Elective-II)

Course Educational Objectives:

- To understand the architecture of micro controllers.
- To understand memory organization, addressing modes and instruction set of microcontrollers.
- To understand interfacing mechanism of microcontrollers.

UNIT-I: 8051 Microcontrollers, Addressing Modes and Instructions

Introduction to Intel 8 bit and 16 bit Microcontrollers, 8051 Architecture, Registers in 8051, 8051 Pin Description, 8051 Connections, 8051 Parallel I/O Ports, Memory Organization, 8051 Addressing Modes, 8051 Instruction Set and Simple Programs, Using Stack Pointer, 8051 Assembly Language Programming, Development Systems and Tools, Software Simulators of 8051

UNIT-II: 8051 Interrupts, Timer/Counters and Serial Communication

Interrupts in 8051, Timers and Counters, Serial Communication, Atmel Microcontrollers (89CXX and 89C20XX), Architectural Overview of Atmel 89C51 and Atmel 89C2051, Pin Description of 89C51 and 89C2051, Using Flash Memory Devices Atmel 89CXX and 89C20XX

Unit-III: Applications of 8051 and Atmel 89C51 and 89C2051 Microcontrollers

Applications of 8051 and Atmel 89C51 and 89C2051 Microcontrollers- Square Wave Generation- Rectangular Waves- Pulse Generation- Pulse Width Modulation- Staircase Ramp Generation- Sine Wave Generation- Pulse Width Measurement- Frequency Counter

UNIT- IV: PIC Microcontrollers

PIC Microcontrollers: Overview and Features, PIC 16C6X/7X,File Selection Register(FSR), PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC),

PIC 16F8XX Flash Microcontrollers :Introduction and architecture of 16F8XX, Registers, Program memory, Data Memory, DATA EEPROM and Flash Program EEPROM, Interrupts in 16F877, I/O Ports, Timers

UNIT- V: Interfacing and Microcontroller Applications- Light Emitting Diodes (LEDs), Push Buttons, Relays and Latch Connections, Keyboard Interfacing, Interfacing 7-Segment Displays, LCD Interfacing, ADC AND DAC Interfacing with 89C51 Microcontrollers

Industrial Applications of Microcontrollers - Measurement Applications, Automation and Control Applications

Course Outcomes:

After completion of this course students are able to:

- Understand different micro controller architectures.
- Wave form generation in 8051 and Atmel microcontrollers.
- Develop interfacing techniques for various applications.

Reference Books:

1. Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGraw Hills
2. Microcontrollers by Kennith J ayala, Thomson publishers
3. Microprocessor and Microcontrollers by Prof C.R.Sarma.

PROCESS CONTROL & AUTOMATION

(Common to CS & CE)

(Elective-II)

Course Educational Objectives:

- To understand process control and hierarchies.
- To understand PLCs and distributed control systems.
- To understand industrial and control applications.

UNIT-I

Fundamentals of Process Control: Definition of industrial processes and control, Hierarchies in process control systems block diagram representation of process control system, Control system instrumentation, Codes and Standards, preparation of P&I diagrams.

UNIT-II

Strategies for Computer-Aided Process Control: Open loop control systems, closed loop (feedback) control system, feed forward control system, cascade control system, ratio control, controller design, controller tuning, tuning of P, PI and PID controllers, Ziegler-Nichols tuning method, selection of controllers, predictive control, model based predictive control, multi-variable control system.

UNIT-III

Programmable Logic Controllers (PLCs): Introduction, principles of operation, architecture of programmable logic controllers, programming the programmable controllers, software, configurations, applications.

UNIT-IV

Distributed Control Systems: Introduction, functional requirements of distributed control system, system architecture, distributed control systems configuration and applications ofdistributed control systems.

UNIT-V

Industrial control Applications: Automation of Thermal power plant, automation strategy, distributed system structure, automatic boiler controller, diagnostic function and protection, digital electro-hydraulic governor, automatic start-up system, thermal stress control, man-machine interface, software system, communication system, variable pressure control, combined plant control.

Course Outcomes:

After completion of this course students are able to:

- Develop different control methods for process control.
- Understand system architectures of PLC's and distribute control systems.
- Understand the automation of Thermal power plant

Reference books:

1. Computer based Industrial Control, Krishna Kant, Prentice-Hall India, 2003.
2. Computer Aided Process Control, S.K.Singh, Prentice-Hall India, 2005.
3. Process Dynamics and Control, Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, John Wiley, 2004.
4. Johnson D Curtis, Instrumentation Technology, Prentice-Hall India, (7^{th} Edition), 2002.

I Year - I Semester

L	P	C
0	4	2

SIMULATION LABORATORY
(Common to CS & CE)

Course Educational Objectives:

- To develop programming and simulation techniques using MAT LAB/SIMULINK.
- To analyze the stability of LTI systems.
- To develop controllers and compensators for linear systems.

Any 10 of the following experiments are to be conducted.

List of Experiments

The following experiments may be implemented in MATLAB/SIMULINK environment.

1. Preliminary Transformations:
   (a) Transfer function to State space models vice- versa.
   (b) Conversion of Continuous to Discrete time systems vice- versa.
   (c) Verification of controllability and observablity of a given system.
2. Design of state feedback controllers.
3. Stability analysis of a given system using:
   (a) Root Locus.
   (b) Bode plot.
   (c) Lyapunov stability.
4. Implementation of Kalman Filter.
5. Implementation of Least squares error method.
6. Implementation of PID controller and its effects on a given system.
7. Design of Lead, Lag, Lead- Lag compensators using frequency domain analysis.
8. Construction of Simulink model for an Induction motor.

Note: At least four problems may be implemented from the following

9. Solving steady state Ricatti Equation.
10. Construction of Simulink model foe single area and multi area Power system.
11. Solving an optimal control problem using Ricatti equation.

12. Implementation of Full order and minimum order Observer.
13. Implementation of Back-Propagation Algorithm.
14. Implementation of simple Fuzzy controller.
15. Implementationof storage and recall algorithm of Hopfield network model.

Course Outcomes:

After completion of this course students are able to:

- Develop conversion models.
- Do stability analysis of LTI system using various techniques.
- Design and implement various controllers, observers and compensators using MAT LAB/SIMULINK.

I Year - II Semester

L	P	C
4	0	3

ROBOTICS AND CONTROL
(Common to CS & CE)

Course Educational Objectives:

- To introduce the rotation mechanics among different parts of robot.
- To understand concept of moving dynamics.
- To introduce the trajectory planning and their control.

UNIT I: Introduction-Robot Anatomy

Coordinate frames-mapping- mapping Between rotated frames-mapping between translated frames-mapping between rotated and translated frames-description of objects in space-transformation of vectors—inverting homogeneous transform-fundamental rotation matrices

UNIT-II: Symbolic Modeling of Robots –Direct and Inverse Kinematic Model

Mathematical structure and notations-description of links and joints-kinematic modeling of the manipulator- Denavit-Hatenberg notation-kinematic relationship between adjacent links-manipulator transformation matrix

Manipulator work space – Solvability of kinematic model- -Solution techniques- closed form solution-guidelines to obtain closed form solution.

UNIT III:

Manipulator Differential Motion, Static and Dynamic Modeling

Linear and angular velocity of a rigid body - Relationship between transformation Matrix and angular velocity - Mapping velocity vector-Velocity propagation along links-Manipulator Jacobian - Jacobian Inverse- Jacobian Singularities- Static Analysis

Lagrangian Mechanics – Two degree of freedom Manipulator-Dynamic Model – Lagrange–Euler formulation - Newton –Euler Formulation – comparison of Lagrange–Euler & Newton – Euler Formulations – Inverse Dynamics

UNIT IV: Trajectory Planning and Control of Manipulators

Definitions and planning tasks- terminology-steps in trajectory planning- Joint space techniques-Cartesian space techniques- Joint space Vs Cartesian space Trajectory planning.

Open and close loop control – The manipulator control problem – Linear control schemes- Characteristics of second order linear systems- Linear Second order-SISO model of a manipulator joint- Joint Actuators- partitioned PD control scheme –PID control scheme – computed torque control- force control of robotic manipulators – description of force control tasks –Force-control strategies-Hybrid position/ force control- Impedance Force/Torque control

UNIT V: Robotic Sensors and Applications

Sensing- Sensors in robotics – Kinds of sensors used in robotics- -Robotic vision- Robotic vision- Industrial applications of vision controlled robotic systems- process of Imaging- Architecture of robotic vision systems- Image Acquisition- Image representation-Image processing – Industrial applications –material handling – Process applications – Assembly applications – Inspection application – Principles of Robot applications and application planning, Justification of robots- Robot safety

Course Outcomes:

Aftercompletion of this course the students are able to:

- Do modeling of Robots with various mapping techniques.
- Do planning and better control of manipulators with open and closed loop controls.
- Apply for various robot applications and their safety measures as criteria.

Reference Books:

1. Robotics and control –RKMittal And I J Nagrath TMH Publishers-1st edition-2003
2. MikellP,WeissG.M.,Nagel R.N., Odrey N.G., Industrial Robotics, McGraw Hill,1986.
3. Deb.S.R- Robotics Technology and flexible automation, Tata McGraw Hill, 1994.
4. Asfahi C.R. - Robotics and manufacturing automation, John wiley ,1992.
5. Klafter R.D.-Chimielewski T.A &Neign M., Robotics engineering: An integrated approach, Prentice Hall of India Pvt.Ltd., 1994.

I Year - II Semester

L	P	C
4	0	3

NONLINEAR SYSTEMS ANALYSIS
(Common to CS & CE)

Course Educational Objectives:

- To introduce nonlinear systems**.**
- To understand the stability concepts.
- To understand the concept of variable structure controllers**.**

UNIT-I

Linear versus nonlinear systems - Fundamentals, common nonlinearities (saturation, dead - zone, on - off non - linearity, backlash, hysteresis) and their describing functions.Existence of limit cycles. Linearization: Exact linearization, input - state linearization, input - output linearization.

UNIT-II

Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non - linear systems using phase plane technique, determination of limit cycles, Poincare index, Bendixon theory.

UNIT-III

Frequency domain analysis of feedback systems: Absolute stability - Circle criterion - Popov criterion. Describing function analysis of nonlinear systems.

UNIT-IV

Concept of stability, stability in the sense of Lyapunov and absolute stability. Zero - input and BIBO stability. Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems.

UNIT-V

Concept of variable - structure controller and sliding control, reaching condition and reaching mode, implementation of switching control laws.Reduction of chattering in sliding and steady state mode. Some design examples of nonlinear systems such as the ball and beam, flight control, magnetic levitation and robotic manipulator etc.

Course Outcomes:

Aftercompletion ofthis course students are able to:

- Analyze nonlinear systems.
- Do stability analysis using different methods.
- Design controllers for nonlinear systems**.**

Reference Books:

1. J. E. Slotine and Weiping LI, Applied Nonlinear Control, Prentice Hall,
2. Hassan K. Khalil, Nonlinear Systems, Prentice Hall, 1996.
3. SankarSastry, Nonlinear Systems Analysis, Stability and Control.
4. M. Vidyasagar, Nonlinear Systems Analysis, Prentice - Hall International editions,1993

I Year - II Semester

L	P	C
4	0	3

DIGITAL SIGNAL PROCESSING
(Common to CS & CE)

Course Educational Objectives:

- To understand the representation of discrete time systems and system functions.
- To understand discrete transformation techniques and their computation procedure.
- To understand the various digital filters design principles.

UNIT-I

Applications of Z Transforms: Review of Discrete Time Sequences and systems – Review of Z-transforms - System functions H(z) of Digital Systems - Stability Analysis - Structure and Realization of Digital Filters: direct – canonic – cascade and parallel form of realization.

UNIT-II

Discrete Fourier Transform (DFT): Discrete time Fourier transform – Discrete Fourier series(DFS) representation of periodic sequences – properties of DFS – Discrete Fourier transform (DFT) – computation of DFT – properties of DFT – convolution of sequences using DFT – IDFT.

UNIT-III

Discrete and Fast Fourier Transform (DFT & FFT): Radix – 2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, IDFT using FFT - Applications of FFT in spectrum analysis and filtering.

UNIT-IV

IIR Digital Filter Design Techniques: Design of IIR Filters from Analog Filters - Analog Filters Approximations: Butterworth and Chebyshev - Frequency Transformations - General Considerations in Digital Filter Design - Bilinear Transformation Method - Step and Impulse Invariance Technique.

UNIT-V

Design of FIR Filters: FIR filters design using Fourier Series Method - Window Function Techniques - Comparison of IIR a FIR Filters. Applications of DSP in Speech Processing.

Course Outcomes:

After completion of this course students are able to:

- Analyze the representation of discrete time system and obtain system functions for design of filters.
- Analyze the computation algorithms of DFT & FFT.
- Design the IIR & FIR filters using various techniques.

Reference Books:

1. "Digital Signal Processing", Alan Oppenheim & Ronald W.Schafer; PHI,2000
2. "Digital signal processing A computer based approach", SanjitK.Mitra , Tata McGraw Hill,2nd Edition,2000.
3. "Digital signal processing principles,Algorithms and Applications" Jhon G.Proakis,DimitrisG.Manolakis, Third Edition,2000,PHI.
4. "Digital Signal Processing', P.RameshBabu, SCITECH Publishers,2004.

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I Year - II Semester

L	P	C
4	0	3

OPTIMAL CONTROL THEORY
(Common to CS & CE

Course Educational Objectives:

- To introduce overall performance measures with variable functions.
- To understand dynamic programming methods.
- To introduce various regulators and algorithms.

UNIT-I

Introduction: Overview of optimization problem, Performance indices, Formulation of Optimal control problem, constrained optimization, unconstrained optimization, Local optimality, Global optimality and their solutions using different techniques, convex sets, convex function, convex programming problem , Sufficient conditions for convex programming problem.

UNIT-II

Calculus of Variation: fundamental concepts, Functions and Functional, Fundamental Theorem of the calculus of Variations, Functional of a single function , Functional involving several independent functions, necessary conditions for optimal control.

UNIT-III

Linear quadratic regulator: Weighting matrices, Finite time Linear Quadratic Regulator, Solution to matrix differential Ricatti equation, Infinite time Linear Quadratic Regulator, Frequency domain Interpretation.

UNIT-IV

Dynamic programming: Principles of optimality, backward solution, forward solution, characteristics of Dynamic Programming solution, Pontryagin Minimum Principle, Hamilton-Jacobi Bellman equation.

UNIT-V

Numerical determination of optimal trajectories: Two point boundary value problem, The method of Steepest descent algorithm, variation of extremals, variation of extremal algorithm, Gradient projection algorithm.

Course Outcomes:

After completion of this course students are able to:

- Develop linear quadratic regulators.
- Determine optimal trajectories.
- Understand various linear and infinite time regulators with better interpretation.

Reference Books:

1. Optimal Control Theory an Introduction, Donald E.Kirk, Prentice –Hall Network Series
2. Optimal Control systems, D.S.Naidu CRC Press
3. Optimal Control Theory, B.D.O.Anderson& Moore-PHI-1991
4. Optimum System Control –A.P.Sage
5. Introduction to optimum design, JasbirS.Arora, Elesevier, 2005.
6. D.P.Bertsekas, Dynamic Programming and optimal Control, Vol.I, 2nd edition, Athena Scientific, 2000.

I Year - II Semester

L	P	C
4	0	3

AI TECHNIQUES
(Common to CS & CE)
(Elective-III)

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in control engineering applications.

UNIT – I

Introduction to Neural Networks: Introduction, Humans and Computers, Biological neural networks, Historical development of neural network, Terminology and Topology, Biological and Artificial Neuron Models. Basic learning laws..

UNIT- II

Feed Forward Neural Networks: Introduction, Perceptron models: Discrete, Continuous and multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron model, Generalised delta learning rule, Feedforward recall and error back propagation training, radial basis function algorithms, Hope field networks.

UNIT III

Genetic Algorithms &Modelling: Introduction-encoding-fitness function-reproduction operators**-**genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm.

UNIT – IV

Classical and Fuzzy Sets: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.Fuzzy Logic System Components:Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

UNIT V

Application of AI Techniques: Fuzzy control systems: simple fuzzy logic controllers & GA with examples, image processing, room heating system, Neural Networks: character recognition networks, inverted pendulum neuro controller, Neural network for Robot kinematics

Course Outcomes:

After completion of this course students are able to:

- Understand neural networks and analyze different types of neural networks.
- Design training algorithms for neural networks.
- Develop algorithms using genetic algorithm for optimization.
- Analyze and design fuzzy logic systems.
- Apply AI Techniques in control engineering applications.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.

EMBEDDED REAL TIME OPERATING SYSTEMS
(Common to CS & CE)
(ELECTIVE-III)

Course Educational Objectives:

- To impart the general embedded system concepts with design of embedded modeling and usage.
- To explain the concepts of real time operating systems based embedded system design.
- To do different case studies along with designing examples with RTOS**.**

UNIT I: Introduction

History of Embedded Systems, Major Application Areas of Embedded Systems, Purpose of Embedded Systems, Core of the Embedded System, Sensors and Actuators, Communication Interface, Embedded Firmware.

UNIT II: Hardware Software Co-Design and ProgrammeModelling

Characteristics of an Embedded System, Quality Attributes of Embedded Systems, Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language (UML),Hardware Software Trade-offs.

UNIT III: Real Time Operating Systems

OS Services, Process Management, Timer .Functions, Event Functions, Memory Management, Device, File and IO Subsystems Management, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real-time Operating Systems, Basic-Design an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the Tasks as Performance Matrices, OS Security Issues.

UNIT IV:Real-Time Operating Systems (RTOS) Based Embedded System Design

Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling :Putting them Altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS.

UNIT V: Design Examples and Case Studies of Progam Modeling and RogrammingWithRTOS-II

Case study of Communication between Orchestra Robots, Embedded Systems in Automobile,
Case study of an Embedded System for an Adaptive Cruise Control(ACC) System in a Car, Case study of an Embedded System for a Smart Card, Case study of a Mobile Phone Software for Key Inputs.

Course Outcomes:

After completion of this course students are able to:

- Analyze and understand the concepts of embedded systems along with design aspects.
- Understand the concept of UML and programme modeling with better hardware-software trade-offs.
- Get the concept of synchronization between RTOs based embedded system design with different applications.
- Able to analyze different types of examples as case studies of present day applications of Smart card, ACC system in a car etc.

Reference Books:

1. Introduction to Embedded System- Shibu KV, Mc-Graw Hill Higher Edition.
2. Embedded Systems Architecture, Programming and Design- Raj Kamal, Second Edition, McGraw-Hill Companies.
3. Embedded System Design by Peter Marwedel, Springer.
4. Embedded System Design – A Unified Hardware/Software Introduction-Frank Vahid, Tony D. Givargis, John Wiley, 2002.
5. Embedded/ Real Time Systems-KVKK Prasad, Dreamtech Press, 2005.
6. An Embedded Software Primer- David E. Simon, Pearson Ed. 2005.

I Year - I Semester

L	P	C
4	0	3

DECISION AND ESTIMATION THEORY
(Common to CS & CE)
(Elective-IV)

Course Educational Objectives:

- To make decisions with respect to single and multiple observations based on digital format.
- To analyze different types of multiple decision tests in general and Gaussian case.
- To discuss different types of estimation methods tofind the objective through normal and Gaussian noise.
- To analyze estimators along with their significance properties in terms of sensitivity and error based.

UNIT-I:

Binary Decisions for single and multiple observations: Maximum-Likelihood decision, Neyman-Pearson, Probability-of-error, Bayes risk and Min-Max Criteria. Vector observations, general Gaussian problem.

UNIT-II:

Multiple decisions: Bayes risk, Probability of error general case and probability of error Gaussian case. Sequential Bayes tests.

UNIT-III:

Fundamentals of estimation: Maximum-Likelihood, Bayes cost methods. Relationship of estimators. Linear Minimum-Variance and Least-Squares estimation.

UNIT-IV:

Estimation with Gaussian noise: Linear observations, Sequential Estimation,
Nonlinear Estimation and State Estimation.

UNIT-V:

Properties of Estimators: Unbiased Estimators, Efficient Estimators, Asymptotic
Properties, Sensitivity and error analysis.

Course Outcomes:

Aftercompletion ofthis course students are able to:

- Digital based decisions and study their effectiveness is studied.
- Better decisions in form of single and multiple cases with better test analysis.
- Different fundamental and Gaussian state estimation methods.
- Various estimators to do the sensitivity and error analysis of different problems.

Reference Books:

1. Decision and estimation theory, J. M. Melsa and D.L. Cohen, Springer-Verlag, 1978
2. H.L. Van Trees, Detection, Estimation, and Modulation Theory, vol. I. Wiley, New York, 1968.
3. S. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall, 1998.
4. S. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993.
5. H. V. Poor, An Introduction to Signal Detection and Estimation, 2nd Ed., Springer-Verlag, 1994.
6. L. L. Scharf, Statistical Signal Processing: Detection, Estimation and Time Series Analysis,Addison-Wesley, 1991.
7. R. Hippenstiel, Detection Theory: Applications and Digital Signal Processing, CRC Press, 2002.

EMBEDDED COMPUTER CONTROL
(Common to CS & CE)
(Elective-IV)

Course Educational Objectives:

- To impart the basic knowledge of embedded computer control concepts.
- To get familiarize with the basic architecture, selection, memory segments.
- To understand the concept of interfacing techniques using different controllers for fine tuning of applications.

UNIT-I
Overview of design challenges and design metrics, Formalisms for system design based various technologies, Combinational logic design, Sequential logic design.

UNIT-II
Basic Architecture, Programming view, Development Environment, Microprocessor selection, General-purpose processor design.

UNIT-III
Timers, UART, Pulse width modulation, LCDs, Keyboards, ADCs and DACs, Memory system mechanisms, Memeory hierarchy and cache Memory management units.

UNIT-IV
Bus architecture, Interrupts, Direct memory access, Introduction to advanced interfacing techniques, Requirement specifications, Design alternatives

UNIT-V
Open-loop and closed-loop control systems, PID controller, Software implementation of PID controller, PID tuning and practical issues

Course Outcomes:
After completion of this course students are able to:

- Understand the basic design concepts of digital integration techniques.
- Understand the overall architecture along with memory management units.
- Develop the operation techniques with interfacing to practical applications along with fine tuning for better output.

Reference Books:

1. Frank Vahid and Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, John Wiley, 2002.
2. Frederick M. Cady , Microcontrollers and Microcomputers Principles of Software, and Hardware Engineering , Second Edition, Oxford University Press ,2009
3. Peter Marwedel, Embedded System Design, Springer, 2006
4. Wayne Wolf, Computers as Components, 2nd Edition, Morgan Kaufmann, 2008

I Year - II Semester

L	P	C
0	4	2

ADVANCED CONTROL SYSTEM LABORATORY

(Common to CS & CE)

Course Educational Objectives:

- To design and observe the performance of control components.
- To design and observes the performance of controllers.

Any 10 of the following experiments are to be conducted.

List of Experiments

1. To obtain the moment of inertia and then develop the transfer function of the given DC Motor for (a) Armature controlled case and (b) Field controlled case. Draw the relevant block diagrams.
2. To conduct experiments on the given amplidyne for (a) To obtain the transfer function (b) To obtain the load characteristics under different levels of compensation (c) To obtain the characteristics of a metadyne.
3. To design a Lag-Lead compensator and to obtain the characteristics by simulation UsingMATLAB®. Verify the performance using experiments with the compensator circuit made of passive elements.
4. To set up a system for closed loop voltage regulation for a dc separately excited generator using amplidyne and to obtain its characteristics
5. To obtain the model of the Inverted pendulum and study the closed loop performance usingexperiments on Bytronic® Inverted Pendulum
6. To conduct experiments on the Level Process Control Station and to study the working of a level control loop.
7. To set up a closed loop feedback control system using the FEEDBACK® MS150 DC Modular Servo System-with velocity (rate) feedback.
8. Temperature controller using PID.
9. To set up an open loop control system using Micro-processor for controlling the stepper motor
10. To design a Lead compensator and to obtain the characteristics by simulation using MATLAB®. Verify the performance using experiments with the compensator circuit made of passive elements.
11. Effect of P, PD, PI, PID Controller on a second order systems
12. Programmable logic controller – Study and verification of truth tables of logic gates, simple Boolean expressions and application of speed control of motor.

Course Outcomes:

After completion of this course students are able to:

- Design circuits to observe the performance of components.
- Design controllers.
- Design speed control methods for motors using PLCs.

Reference Books:

1. Gene F Franklin, J David Powell, Abbas EmamiNaeini, Feedback Control of Dynamic Systems, 4th Ed, Pearson Education Asia, 2002
2. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, Control System Design, Prentice Hall India, 2003.
3. John J D'Azzo, Constantine H Houpis, Stuart N. Sheldon, Linear Control System Analysis & Design with MATLAB, 5th Ed, Marcel Dekker, 2003
4. John E Gibson, Franz B. Tuteur, Control System Components, McGrawHill, 1958
5. Users' Manual for FEEDBACK® MS150 AC Modular Servo System
6. Users' Manual for 8085n Microprocessor kit, ©ViMicroSystems.
7. www.mathworks.com
8. Users' Manual for Bytronic® Inverted Pendulum.
9. Users' Manual for Level Process Station, ©Vi McroSystems

II Year - III Semester

L	P	C
0	0	2

COMPREHENSIVE VIVA-VOCE

II Year - III Semester

L	P	C
0	0	2

SEMINAL - I

II Year - III Semester

L	P	C
0	0	16

PROJECT WORK PART - I

II Year - IV Semester

L	P	C
0	0	2

SEMINAR - II

II Year - IV Semester

L	P	C
0	0	18

PROJECT WORK PART - II

ACADEMIC REGULATIONS & COURSE STRUCTURE

For

HIGH VOLTAGE ENGINEERING (HVE) & POWER SYSTEMS WITH EMPHASIS ON H. V. ENGINEERING (PSHVE)

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Semester

S. No.	Subject	L	P	Credits
1	Generation and Measurement of High Voltages	4	--	3
2	Dielectric and Insulation Engineering	4	--	3
3	HVDC Transmission	4	--	3
4	Power System Operation and Control	4	--	3
5	**Elective – I** i. Artificial Intelligence Techniques ii. Advanced Digital Signal Processing iii. Smart Grid Technologies iv. Breakdown Phenomenon in Electrical Insulation	4	--	3
6	**Elective – II** i. GAS Insulated Systems and Substations ii Collision Phenomena in Plasma Science iii. Advanced EM Fields	4	--	3
7	High Voltage Laboratory	--	4	2
Total Credits				**20**

II Semester

S. No.	Subject	L	P	Credits
1	High Voltage Testing Techniques	4	--	3
2	EHVAC Transmission	4	--	3
3	Surge Phenomenon & Insulation Coordination	4	--	3
4	Advanced Power System Protection	4	--	3
5	Elective – III i. Partial Discharge in HV Equipment ii. High Voltage systems using EMTP Analysis iii. Pulse Power Engineering	4	--	3
6	Elective – IV i. Flexible AC Transmission Systems ii. Power System Deregulation iii. Reactive Power compensation & Management	4	--	3
7	Simulation Laboratory	--	4	2
Total Credits				**20**

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	**--**	**--**	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				**20**

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				**20**

I Year - I Semester

L	P	C
4	0	3

GENERATION & MEASUREMENT OF HIGHVOLTAGES
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

Prerequisites: Basicsof Electrical circuits, Electronics and measurements for testing purpose

Course Educational Objectives:

- To study the numerical methods for analyzing electrostatic field problems.
- To study the fundamental principles of generation of high voltage for testing.
- To study the methods for measurement of high AC, DC and transient voltages.
- To Study the measurement techniques for high AC, DC and impulse currents.

UNIT 1- Electrostatic fields and field stress control: Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method.

UNIT 2-Generation of High AC & DC Voltages:
Direct Voltages: AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers.
Alternating Voltages: Testing transformers-Resonant circuits and their applications, Tesla coil.

UNIT 3-Generation of Impulse Voltages :
Impulse voltage specifications-Impulse generations circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.
Impulse Currents : Generation of High impulse currents and high current pulses.

UNIT 4- Measurement of High AC & DC Voltages :
Measurement of High D.C. Voltages : Series resistance meters, voltage dividers and generating voltmeters.
Measurement of High A.C. Voltages : Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.

UNIT 5-Measurement of Peak Voltages : Sphere gaps, uniform field gaps, rod gaps.Chubb-Fortesque methods.Passive and active rectifier circuits for voltage dividers.
Measurement of Impulse Voltages : Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.
Measurement of Impulse Currents : Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.

Course Outcomes:

After completion of the course the student will be able to:

- Understand numerical computation of electrostatic problems.
- Understand the techniques of generation of high AC, DC and transient voltages.
- Measure high AC, DC and transient voltages.
- Measure high AC, DC and transient currents.

Reference Books :

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.
3. High Voltage Technology – LL Alston, Oxford University Press 1968.
4. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.
5. Relevant I.S. and IEC Specifications.

I Year - I Semester

L	P	C
4	0	3

DIELECTRICS AND INSULATION ENGINEERING

(Common to HVE, PSHVE)

Prerequisites: Concepts of High voltage engineeringand basic physics.

Course Educational Objectives:

- To understand the electrical properties of insulating materials.
- To understand the principles of dielectric failure in insulating materials.
- To understand the application of insulating materials in different electrical apparatus.

UNIT 1-Dielectrics and Insulating Materials: Review of Dielectric Phenomenon: Complex permittivity – Polarization - Relaxation and resonant models. Solid, Liquid and Gaseous insulating materials-Physical, Thermal & Electrical properties-Classification of Insulating Materials.

UNIT 2-Solid Insulating Materials: Organic Fiber materials Ceramics & Synthetic polymers and their applications.
Liquid Insulating Materials: Insulating oils, their properties and applications.
Gaseous Insulating Materials: Air and SF_6- applications in electrical apparatus.

UNIT 3-Breakdown phenomenon in gaseous and vacuum insulation: Insulation and decay processes-transition from self-sustained discharges to breakdown-Townsend and streamer discharge Paschen's law,Penning effect-Time lags-Surge breakdown voltage-Breakdown an non uniform fields-Vacuum insulation and vacuum breakdown.

UNIT 4-Breakdown Phenomenon in Liquid and Solid Insulation: pure and commercial liquids-suspended particle and bubble theories-stressed oil volume theory-Breakdown in solid insulation Intrinsic breakdown-Treeing and tracking phenomenon-Thermal breakdown—Breakdown in composite dielectrics.

UNIT 5-Insulation Engineering: Insulation design for power cables, capacitors, bushings, switchgear, transformers and rotating machines-resents trends.

Course Outcomes:

After completion of the course, students will be able to:

- Properties of insulating materials.
- Electrical breakdown in gas and vaccum insulation.
- Electrical breakdown in liquid and solid insulation.
- Insulation design in electrical power apparatus.

Reference Books:

1. High Voltage Engineering – by E.Kuffel and W.S. ZaegnlPergamon press, Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw-Hill Books Co., New Delhi, 2nd edition, 1995.
3. Electrical Engineering Materials – B. Tareev, M.I.R. Publications, MOSCOW.
4. Physics of Dielectrics - B. Tareev, M.I.R. Publications, MOSCOW
5. High Voltage Technology - LL Alston, Oxford University Press 1968.
6. Insulation Engineering- by Arora ,John Wiley & Sons
7. Insulating Materials-by Dekker,S.Chanda& Co
8. Dieletrics and waves-by vonhipple,John Wiley & Sons

I Year - I Semester

L	P	C
4	0	3

HVDC TRANSMISSION
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE,PSHVE, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Knowledge onPower Electronics, Power Systems and High Voltage Engineering

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

UNIT -1: Limitation of EHV AC Transmission and advantages of HVDC Technical economical reliability aspects.HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

UNIT-2: Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

UNIT-3 : Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.

UNIT-4 : Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT -5 : Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes:

After completion of the course, students will be able to:

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.
- Understand the various protection schemes of HVDC engineering.

Reference Books:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
3. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
3. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
4. Vijay K Sood:HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press.

I Year - I Semester

L	P	C
4	0	3

POWER SYSTEM OPERATION AND CONTROL
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

Prerequisites: Knowledge on Power Generation Engineering, Power Transmission Engineering.

Course Educational Objectives:

- To Study the unit commitment problem for economic load dispatch.
- To study the load frequency control of single area and two area systems with and without control.
- To study the effect of generation with limited energy supply.
- To study the effectiveness of interchange evaluation in interconnected power systems.

UNIT-1 : Unit commitment problem and optimal power flow solution : Unit commitment : Constraints in UCP,UC solutions. Methods-priority list method, introduction to Dynamic programming Approach.

UNIT-2 : Single area load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control and Economic dispatch control.

UNIT-3 : Two area Load Frequency Control: Load frequency control of 2-area system : uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment.

UNIT-4 : Generation with limited Energy supply : Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.

UNIT-5 : Interchange Evaluation and Power Pools Economy Interchange, Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange contracts. After-the-fact production costing, Transmission Losses in transaction Evaluation, other types of Interchange, power pools.

Course Outcomes:
After completion of the course, students will be able to:

- Determine the unit commitment problem for economic load dispatch.
- Get the knowledge of load frequency control of single area and two area systems with and without control.
- Know the effect of generation with limited energy supply.
- Determine the interchange evaluation in interconnected power systems.

Reference Books :

1 Modern Power System Analysis - by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.

2 Power system operation and control PSR Murthy B.S publication.

3 Power Generation, Operation and Control - by A.J.Wood and B.F.Wollenberg,Johnwiley& sons Inc. 1984.

4 Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.

5 Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

I Year - I Semester

L	P	C
4	0	3

ARTIFICIAL INTELLIGENCE TECHNIQUES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

(Elective-I)

Prerequisites: Basic knowledge on human biological systems, concept of optimization and electrical engineering.

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in electrical engineering.

UNIT – 1: Introduction to Neural Networks

Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

UNIT- 2:Feed Forward Neural Networks

Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks

UNIT -3: Genetic algorithms &Modelling-introduction-encoding-fitness function-reproduction operators**-**genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

UNIT – 4:Classical and Fuzzy Sets

Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.

Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

UNIT 5: Application of AI Techniques-load forecasting-load flow studies-economic load dispatch-load frequency control-reactive power control-speed control of dc and ac motors

Course Outcomes:

After completion of the course, students will be able to :

- Understand neural networks and analyze different types of neural networks.
- Design training algorithms for neural networks.
- Develop algorithms using genetic algorithm for optimization.
- Analyze and designfuzzy logic systems.
- Apply AI Techniques in electrical engineering.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan andPai – PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.

ADVANCED DIGITAL SIGNAL PROCESSING

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

(Elective I)

Perquisites: Knowledge on signal processing and Z-transform.

Course Educational Objectives:

- To have knowledge on structures of different digital filters.
- To design digital filters with different techniques.
- To understand the implementation aspects of digital filters.
- To analyze the effect of finite word length in signal processing.
- To understand power spectrum estimation techniques in signal processing.

UNIT-1: Digital Filter Structure

Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT-2: Digital filter design

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass high pass-Band pass, and Band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean- Square-error-constrained Least-square design of FIR digital filters

UNIT-3: DSP algorithm implementation

Computation of the discrete Fourier transform- Number representation-Arithmetic operations-handling of overflow-Tunable digital filters-function approximation.

UNIT-4: Analysis of finite Word length effects

The Quantization process and errors- Quantization of fixed -point and floating -point Numbers-Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors, Dynamic range scaling-signal- to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters-Round-off errors in FFT Algorithms.

UNIT 5: Power Spectrum Estimation

Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – parametric method for power spectrum Estimation, Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

Course Outcomes:

After completion of the course, students will able to:

- Describe structure of digital filters.
- Design digital filters with different techniques.
- Understand the implementation aspects of signal processing algorithms.
- Know the effect of finite word length in signal processing.
- Analyze different power spectrum estimation techniques.

Reference Books:

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
3 Digital Signal Processing principles, algorithms and Applications – John G.Proakis -PHI –3rd edition-2002
4. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
5. Theory and Applications of Digital Signal Proceesing-LourensR.Rebinar&Bernold
6. Digital Filter Analysis and Design-Auntonian-TMH

SMART GRID TECHNOLOGIES

(Common to HVE, PSHVE)

(Elective – I)

Perquisites: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

UNIT 1

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT 2

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT 3

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT 4

Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:

After completion of the course, students will be able to:

- Understand smart grids and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley publishers.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active DistributionNetworks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

BREAKDOWN PHENOMENON IN ELECTRICAL INSULATION
(Gases, Liquids, Solids and Vacuum)
(ELECTIVE-I)
(Common to HVE, PSHVE)

Prerequisites: Basic physics, conduction phenomena in dielectrics.
Course Educational Objectives:

- Understand the fundamental processes of conduction in gases.
- Ionization and breakdown phenomena in gases.
- Breakdown phenomena in liquid and solid dielectrics.
- Breakdown phenomena in vaccum.

UNIT 1: Fundamentals of Electrical Breakdown Phenomena in Gases:
Review of gas laws-mean free path of a particle-velocity distribution of swarm of molecules-Expression for mean free path (λ)-Distribution of free paths-Bohr's model of an atom .calculation of radius of Bohr's orbit Energy of an electron-Ionization energy of an atom calculation of frequency of emitted radiation.

UNIT 2: Ionization Its Gases:
Methods of ionization in gases-Ionization by collision-types of inelastic collisions – collision cross sections.
Behavior of charged particles in a gas in electric fields of low (E/P)-drift velocity –mobility conditions for low (E/P).
Electrical Breakdown in Uniform Fields:
Voltage-current relationship is gaseous gap (small gaps)-condition for high (E/P)-Townsend's first Ionization coefficient (α) - (α/p) is a function of (E/P)-Experimental determination of (α) – Penning effect

UNIT 3:Self-sustained discharge:
β-process and its limitations cathode process –methods of liberating secondary electrons – Townsend's second ionization coefficient -γ -process . Condition for electric spark breakdown. Secondary emission by gas produced photons – Meta stables-Role of solid contaminants. Electron Attachment, electronegative gases (SF_6etc).
Measurement of 'γ'- Paschen's law –expression for Minimum Breakdown voltage and minimum (Pd_{min}) - limitations of Paschen's law.
Breakdown of long gaps: Streamer Mechanism- Explanation for positive streamer. Estimation of space charge fields (Es) - Anode directed streamer - comparison between Townsend and streamer mechanism. Breakdown in non-uniform fields –corona discharges - difference between DC and AC corona. Effect of polarity on break down of point-plane gaps.

UNIT 4: Breakdown in Solids and Liquid Insulations:
Types of Breakdown: Intrinsic Breakdown – Electronic Breakdown – Streamer Breakdown – Electromechanical Breakdown –Thermal Breakdown -treeing and tracking. Electro – Chemical Breakdown – BD due to thermal discharges.

Breakdown in liquids dielectrics:
Pure and commercial liquids – Breakdown tests – Pre-breakdown currents and breakdown in pure liquids – breakdown in commercial liquids –Suspended particle theory, cavitations and bubble mechanism. Thermal breakdown – Stressed oil – Volume Theory.

UNIT 5: Breakdown in Vacuum Insulation:
Pre-Breakdown currents – Steady currents –Micro discharges-Factors affecting the Breakdown . like electrode separation - electrode conditioning - electrode material –Surface condition surface contamination - electrode area and configurations –effect of electrode temperature – frequency of applied voltage – pressure - recovery strength of vacuum gap. Practical Exchange theory –electron beam Hypothesis – Clump mechanism- transition in breakdown mechanisms – criteria for B.D - effect of solids dielectrics in vacuum and liquids.

Course Outcomes: After completion of this course the students will be able to:

- Understand the fundamental process of conduction in gases.
- Understand ionization and breakdown phenomena in gases.
- Understand breakdown phenomena in liquid and solid dielectrics.
- Understand breakdown phenomena in vaccum.

References Books:

1. Fundamentals of gaseous ionization and plasma electronics by EssamNassar,John Wiley, New York (1974).
2. High voltage & electrical insulation by RavindraArora , John willy and sons.
3. High voltage technology –L.L.Alston -Oxford Press (1968).
4. High voltage Engineering Fundamentals E. Kuffel, W. S. Zaengl,andJ. Kuffel oxford (2002).
5. High voltage Engineering, M.S.Naidu and V.Kamaraju (5th edition) McGraw Hill Publishing Co., New Delhi (2011).

I Year - I Semester

L	P	C
4	0	3

HIGH VOLTAGE POWER APPARATUS AND DIAGNOSTICS

(Common to HVE, PSHVE)

(Elective-II)

Prerequisites: To know about power transformers, Degree of polymerization, dissolved gas analysis, Fourier Transformer and frequency response analysis of transformers.

Course Educational Objectives:

- To study about components of power transformer, types of insulation material, overvoltage due to lightning impulse & faults.
- To study the measurement of resistivity and capacitance of transformer oil, method of measurement of tan delta and analysis to detect ageing.
- To study the concept of moisture in transformer oil and paper and partial discharges detection methods within transformer volume.
- To study the degree of polymerization and to determine tan delta and capacitance in transformer bushing.
- To Study the concept of Fourier Transformer with regard to configuration of winding, frequency response analysis of transformer winding..

UNIT 1: Introduction to power transformer, important components of power transformer, winding configuration, various types of insulation material, LV and HV bushings, cooling of winding. Reasons of failure of transformer, short circuit, overvoltage due to switching operation, inadequate clearances between various windings, over-voltage due to lightning impulse, over voltage due to fault, high level of partial discharges, inappropriate design, over fluxing.

UNIT 2 : Tan delta, capacitance in transformer winding, method of measurement of tan delta and capacitance in transformer ,Tan delta ,resistivity and capacitance of transformer oil, bushing capacitance ,tan delta and resistivity, on-site measurement, analysis to detect ageing and likely failure

UNIT 3: Moisture in transformer oil and paper, ageing effect of paper, insulation resistance, Method of measurement of polarization, polarization value, method of moisture reduction, winding resistance, Influence with regard to life of transformer. Partial Discharges in transformer, causes of partial discharges, concept of partial discharges, acoustic method of measurement of partial discharges, discharges in oil, discharges in paper, method of reduction of partial discharges, analysis and detection of partial discharge sites within transformer volume.

UNIT 4 : Degree of polymerization (DP) of transformer paper, effect of DP on life of transformer, effect of transformer temperature on degree of polymerization, furfural content in oil insulation, inter – relationship between degree of polymerization and furfural content, reduction of degree of polymerization in transformer paper. Dissolved gas analysis in transformer oil, various gas product in transformer oil, tolerable level of gases in transformer

onload , detection of important gases in transformer, causes of various gases, likely reason of gases with reference to high temperature and partial discharges.

UNIT 5: Fourier Transform and frequency response analysis of transformer winding, concept of Fourier Transformer with regard to configuration of winding, low, medium and high frequency comparison of frequency response of LV , HV and tapping winding, concept of winding movement on the basis of frequency comparison, turn failure.

Course Outcomes:

After completion of this course the students will be able to

- learn power transformer, types of insulation material.
- the measurement of tan delta and capacitance of transformer oil.
- know the concept of moisture in transformer oil and paper and partial discharges.
- know degree of polymerization.
- know concept of Fourier Transformer and frequency response analysis of transformer winding.

Text Book:

1. Transformer, Bharat Heavy Electricals Limited (Bhopal), Second edition 2003,First Edition 1987 Tata Mc.Graw-hill Publishing Company Ltd. Mc.Graw –Hill officePage 1- 602

Reference book:

1 Seminar on fault finding and life assessment of power transformers Proceedings 25- 26 April2008 New Delhi, Organized by Central Board of Irrigation and Power, New Delhi in association with Omicron India.

2. Transformer Engineering, Blue mend boission, Wiley international publication.

COLLISION PHENOMENA IN PLASAMA SCIENCE

(Common to HVE, PSHVE)

(Elective-II)

Prerequisites: Introduction to plasma physics and quantum physics

Course Educational Objectives: student will be exposed to

- Plasmas and their characterizations
- Charged particle motion in electromagnetic fields.
- Electron Avalanche mechanisms.

UNIT 1 : Ionization, Deionization and Electron Emission :Ionization and plasma conductivity, Production of charged particles, Ionization by cosmic rays, Thermal ionization. The free path, excited states, metastable states.Diffusion, Recombination, Negative ions.Photoelectric emission, Thermionic emission, Field emission.

UNIT 2 : Behavior of charged particles in a gas in electric fields of low E/P and high E/P, Definition and significance of mobility, Forces between ions and molecules, Diffusion under low fields, Electron drift velocity.

UNIT 3 : What is high E/P?, Coefficient of ionization by electron collision, evaluation of $\propto$, electron avalanche, effect of the cathode, Ionization coefficient in alternating fields.
The Self-Sustaining Discharge Breakdown Mechanisms: Ionization by positive-ion collision, Cathode processes, space-charge field of an avalanche. Critical avalanche size,

UNIT 4: Townsend mechanism and its limitations, Streamer formation. The transition between the breakdown mechanisms, The effect of electron attachment.
Partial Breakdown and Breakdown Under Alternating Fields: Electron current, positive-ion current, total current, characteristic time, effect of space charge, Anode coronas, Cathode coronas.

UNIT 5: The Glow and Plasma: General description, The cathode zone, Negative glow and Faraday dark space, positive column, Anode region, other effects.
Definition of plasma, Debye length, scope of known plasmas, Plasma oscillations, high-temperature plasmas, Plasma diagnostics.

Course Outcomes: After completion of this course the students will be able to

- Understand the collision phenomena in different materials.
- Transition from Streamer to Townsend mechanisms of breakdown.
- Electric glow discharge and plasma glow discharge.

Reference Book:

1. Fundamentals of Gaseous Ionization And Plasma Electronics by Essam Nasser, John Willey & Sons, Printed in America, 1971.

ADVANCED EM FIELDS
(Common to HVE, PSHVE)
(Elective-II)

Prerequisites: To know the elements of Electromagnetic and electro static field theory along with the behavior of conductors in an electric field.

Course Educational Objectives:

- To know the analytical calculations of field with space charges electric stress and equation of continuity.
- To know the electric field inside a dielectric material, energy density in a static electric field.
- To know the numerical methods for calculating electrical fields, statically dynamically induced e.m.f. calculations of transmission lines conductors to ground.

UNIT – 1: Electrostatics:
Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Gauss's law – Application of Gauss's Law – Maxwell's first law, div (D)=ρv – Laplace's and Poisson's equations – Solution of Laplace's equation in one variable

UNIT – 2 :Electric fields-1
Introduction, Analytical calculation of space-charge-free fields, simple geometries, transmission conductors to ground, fields in multidielectric media, experimental analogs for space-space-charge-free fields, electrolytic tank, semi conducting paper analog, resistive-mesh analog.,

UNIT – 3 Electric fields-2
Analytical Calculations of Fields With Space Charges, Numerical Computation of Fields With Space Charges, Finite Element Technique, Finite Element Technique Combined With The Method Of Characteristics, Charge-Simulation Technique Combined With The Method Of Residues, Electric Stress Control And Optimization, Electric Stress Control, Electric Stress Optimization

UNIT – 4 : Conductors & Dielectrics :
Behavior of conductors in an electric field – Conductors and Insulators – Electric field inside a dielectric material – polarization – Dielectric – Conductor and Dielectric – Dielectric boundary conditions – Energy stored and energy density in a static electric field – Current density – conduction and Convection current densities – Ohm's law in point form – Equation of continuity

UNIT – 5: Force in Magnetic fields &Time Varying Fields:
Magnetic force - Moving charges in a Magnetic field – Lorentz force equation — a differential current loop as a magnetic dipole ,Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point forms ,Statically and Dynamically induced EMFs -Modification of Maxwell's equations for time varying fields – Displacement current

Course Outcomes:

After completion of this course the students will be able to:

- know about analysis of electrostatic fields and properties of potential gradients.
- knows about the dielectric boundary conditions and electric stress control and optimization and time varying fields.

Text Books:

1. "Engineering Electromagnetic" by William H. Hayt& John. A. Buck McGraw-Hill Companies, 7th Editon.2005.
2. "Electromagnetics" by J. D Kraus Mc.Graw-Hill Inc. 4th edition 1992.

Reference Books:

1. Field Theory ", Gangadhar, Khanna Publishers.
2. Elements of Electromagnetic field theory ", Sadiku, Oxford Publ.
3. "Electromagnetics" by J P Tewari.
4. "Introduction to E-Magnetics" by CR Paul and S.A. Nasar, McGraw-Hill Publications
5. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt.Ltd, 2nd editon
6. "Electromagnetics" by Plonsy and Collin
7. "Engineering Electro magnetics" by Nathan Ida, Springer (India) Pvt. Ltd.2nd Edition.

I Year - I Semester

L	P	C
0	4	2

HIGH VOLTAGE LABORATORY

(Common to HVE, PSHVE)

Course Educational Objectives:

To understand the operation of high voltage generation and testing the various insulators.

Any 10 of the following experiments are to be conducted

List of Experiments:

1. Millivolt drop test and Tong tester calibration
2. Breakdown characteristics of sphere-sphere gap
3. Measurement of Leakage current and breakdown voltage of pin insulator
4. Breakdown test of transformer oil
5. Breakdown characteristics of rod-rod gap
6. Measurement of Leakage current and insulation resistance of polypropylene scale
7. Measurement of Leakage current and insulation resistance of polypropylene rope
8. Breakdown characteristics of plane-rod-gap
9. Measurement of leakage current and breakdown voltage of suspension insulator
10. Breakdown characteristics of point-sphere gap
11. Measurement of tan delta and dielectric constant
12. Power frequency testing of HV transformer
13. Power frequency testing of HV Bushing
14. Power frequency testing of HV Cable.

Course Outcomes:

After the Completion of lab will understand testing procedures of various insulators.

I Year - II Semester

L	P	C
4	0	3

HIGH VOLTAGE TESTING TECHNIQUES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

Prerequisites: Basics of high voltage engineering.

Course Educational Objectives:

- To understand Nondestructive testing methods.
- To understand Commercial and technical testing of different HV power applications.

UNIT 1 : Non Destructive Testing Techniques : Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors.

UNIT 2 : High Voltage Testing of Power Apparatus : Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests – Tests for cap and pin porcelain/Glass insulators.

UNIT 3 : High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables. Artificial Contamination Tests : Contamination flashover phenomena-Contamination Severity-Artificial contamination tests-Laboratory Testing versus in-Service Performance-Case study.

UNIT 4 : Impulse Testing : Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.

UNIT 5 : Partial Discharge Measurement : PD equivalent model-PD currents-PD measuring circuits-Straight and balanced detectors-Location and estimation of PD in power apparatus-PD measurement by non electrical methods-Calibration of PD detectors. RIV Measurements : Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations.

Course Outcomes:

After completion of this course the students will be able to:

- Understand different testing procedures on electrical a) Insulating materials b) Insulation Systems.c) Power apparatus.
- Learn the different testing techniques adopted on electrical power apparatus.

Reference Books :

1. High Voltage Engineering – by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw Hill Publishing Company Limited, New Delhi – 2001.
3. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
4. Hyltencavallius. N. High voltage laboratory planning EnileHaefely&Co. Ltd. Based Switzerland 1988
5. Ryan H.M. and Whiskand: design and operation perspective of British UHV Lab IEE pre 133 H.V. Testing Techniques Halfly

I Year - II Semester

L	P	C
4	0	3

EHVAC TRANSMISSION

(Common to HVE,PSHVE)

Prerequisites: Transmission line parameters and properties, Corona etc.

Course Educational Objectives:

- To calculate the transmission line parameters.
- To calculate the field effects on EHV and UHV AC lines.
- To have knowledge of corona, RI and audible noise in EHV and UHV lines.
- To have knowledge of voltage control and compensation problems in EHV and UHV transmission systems.

UNIT-1: E.H.V. A.C. Transmission , line trends and preliminary aspects ,standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation.capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

UNIT-2 : Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

UNIT-3 : Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

UNIT-4 : Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

UNIT -5 : Static reactive compensating systems : Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

Course Outcomes: After completion of the course, the student will be able to:

- Calculate the transmission line parameters.
- Calculate the field effects on EHV and UHV AC lines.
- Determine the corona, RI and audible noise in EHV and UHV lines.
- Analyze voltage control and compensation problems in EHV and UHV transmission systems.

Reference Books :

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

I Year - II Semester

L	P	C
4	0	3

SURGE PHENOMENON AND INSULATIONCO-ORDINATION

(Common to HVE, PSHVE)

Prerequisites: Basic concepts oftravelling wave techniques and their applications in electrical power systems, lightening and switching over voltages, insulation co-ordination in power systems.

Course Educational Objectives:

- To understand travelling wave phenomenon in transmission systems.
- To know different types of over voltages that originate in power systems.
- To know Insulation gradation for different electrical power apparatus and coordination in insulation systems.

UNIT 1 : Traveling Waves : Transmission line equation, attenuation and distortion point-Typical cases.
Reflection of traveling waves: Behaviors of waves at a transaction point-Typical case. Travelling waves on multi conductor systems

UNIT 2 : Successive Reflections : Reflection lattice, Effect of insulation capacitance. Standing waves and natural frequencies of transmission lines-Transient response of lines and systems with distributed parameters.

UNIT 3 : Lightning Phenomena and over voltage in power systems. Mechanism of the lightning stroke – Mathematical model of the lightning stroke. Over voltages produced in power systems due to lightning – Over voltage due to faults in the system and switching surges. General principles of lightning protection – Tower – Footing resistance – Insulation withstand voltages and impulse flashover characteristics of protective gaps.

UNIT 4 : Surge Voltage distribution in transformer windings initial and final distribution characteristics : Protection of windings against over voltages. protection of transmission lines, transformers and rotating machines against over voltages. Use of rod gaps and lightning arresters protective characteristics.Selection of the lightning arresters.

UNIT 5 : Insulation coordination lightning surge and switching surge characteristics of insulation structures. Geo-metric gap factors test procedures, correlation between insulation for protective levels. Protective devices Znoarresters,vale type-etc, protective tubes

Course Outcomes: After completion of this course the students will be able to:

- Understand line concepts of travelling waves and their behavior in transmission systems.
- Understand lighting phenomena and over voltages in power systems.
- Understand the behavior of the transformer when surge voltages are induced in the windings.
- Understand the insulation coordination between different protecting and protective devices in the power system.

Reference Books :

1. Traveling waves of Transmission systems – by LV Bewley. Dover publications Inc., New York (1963).
2. Lewis, w.w., protection of transmission lines and systems against lightining, dover publications, Inc., New York (1965).
3. Diesendorf.W, Insulation Co-ordination ELBS in H.V. Electrical Power Systems , Butter worth publications, London, (1974).
4. Rakesh Das Begmudre,E.H.V. Transmission Engineering: Wielly Eastern Ltd., New Delhi, (1986).

I Year - II Semester

L	P	C
4	0	3

ADVANCED POWER SYSTEM PROTECTION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS)

Prerequisites: Concepts of Power Electronics, Electronic circuits, STLD and basics of Relays and protection.

Course Educational Objectives:

- To learn about classification and operation of static relays.
- To understand the basic principles and application of comparators.
- To learn about static version of different types of relays.
- To understand about numerical protection.

UNIT 1 : Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT 2 : Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT 3 : Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

UNIT 4 : PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT 5 : Microprocessor based relays andNumerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay.
Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Course Outcomes:

After completion of the course, the student will be able to:

- Know the classifications and applications of static relays.
- Understand the application of comparators.
- Understand the static version of different types of relays.
- Understand the numerical protection techniques.

Reference Books :

1. Power System Protection with Static Relays – by TSM Rao ,TMH.
2. Protective Relaying Vol-II Warrington, Springer .
3. Art & Science of Protective Relaying - C R Mason, Wiley.
4. Power System Stability KimbarkVol-II, Wiley.
5. Power system protection & switchgear by Badri Ram & D N viswakarma. TMH.
6. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
7. Protection & Switchgear –BhaveshBhalaja,R.PMaheshwari, NileshG.Chothani-Oxford publisher

I Year - II Semester

L	P	C
4	0	3

PARTIAL DISCHARGES IN HV EQUIPMENT

(Common to, HVE, PSHVE)

(Elective-III)

Prerequisites: Knowledge in High Voltage Equipment.

Course Educational Objectives:

- To know about Partial Discharges, necessity of detection of partial discharge
- To know about effects of partial discharges on insulating systems.
- To know different detection methods used for partial discharges.

UNIT 1 : Types of partial discharges and its occurrence and recurrence and magnitudes : Definition of Partial discharges, inception of internal discharges, Inception of corona discharges.

UNIT 2 : Discharges by electrical treeing. Discharges at AC Voltages, corona discharges, Discharges at D.C. Voltages, discharges at impulse voltages.
Object of discharge detection, Quantities related to the magnitude of discharges, choice of PD as a measure for discharges.

UNIT 3 : Electrical discharge detection & Detection circuits : Basic diagram, amplification of impulses, sensitivity, resolution, observation. Straight detection.
Balanced detection, calibrators, Interferences, choice between straight detection & balance detection, common mode rejection.

UNIT 4 : Location of Partial discharges : Non-electric location, location by separation of electrodes, location with electrical probes. location by traveling waves, PD location in cables & switchgear by traveling waves. Evaluation of discharges: Recognition, mechanisms of deterioration, evaluation, specification.

UNIT 5 : Detection in actual specimen : Detection in capacitors, cables, bushings. Transformers, machine insulation, Gas-insulated switchgear.

Course Outcomes:

After completion of the course, the student will be able to:

- Types of partial discharge that occurs in the insulation systems and in apparatus.
- Detection of discharges using different detection circuits.
- Location of partial discharge in electrical apparatus and systems.

Reference Book :

1. Partial Discharges in HV Equipment by F..Kruguer, Butterworths& Co., Publications Ltd., 1989.
2. *Partial Discharges in Electrical Power Apparatus.* by Dieter Konig, Y. *NarayanaRao-* VDE-Verlag publisher

GAS INSULATED SYSTEMS AND SUBSTATIONS

(Common to, HVE, PSHVE)

(Elective-III)

Prerequisites: Conduction and Breakdown in gases, and substation.

Course Educational Objectives:

- To Study and learn about SF_6 gas properties and application in electrical apparatus.
- To Study and learn about Details of SF_6 Substation.
- To Study and learn about Testing of G.I.S.

UNIT 1

Introduction to GIS and Properties of SF6:

Characteristics of GIS, Introduction to SF_6, Physical Properties, Chemical Properties, Electrical Properties, Specifications of SF_6 Gas for GIS Applications, Handling of SF_6 Gas Before Use, Safe Handling of SF_6 Gas in Electrical Equipment, Equipment for Handling the SF_6 Gas, SF_6 and Environment.

UNIT 2

Layout of GIS Stations:

Advantages of GIS Stations, Comparison With Air Insulated Substations, Economics of GIS,User Requirements for GIS,Main Features of a GIS,General Arrangement of a GIS,Planning and Installation,Components of a GIS station.

UNIT 3

Design and Construction of GIS Stations:

Introduction,Ratings of GIS Components,DesignFeatures,Estimation of Different types of Electrical Stresses,Design Aspects of GIS Components,Insulation Design for GIS,Thermal Considerations in the Design of GIS,Effect of Very Fast Transient over voltages(VFTO)on the GIS Design,Insulation Coordination in GIS ,GIS Grounding Systems,Gas handling and Monitoring System Design.

UNIT 4

Testing of GIS

Introduction, Various Tests on GIS,Design Approach for Manufacturing and Type Tests,Quality Assurance in Manufacturing,Shipping and Erection,On-Site Testing of GIS, Dielectric Tests, commonly used On-site Test Methods,Experience during On-Site Testing,Condition Monitoring and Diagnostic Methods.

UNIT 5

GIS Diagnostics and Fast Transient Phenomena in GIS

Introduction,Characteristics of imperfections inInsulation,Insulation Diagnostic Methods,PDMeasurement,UHFMethod,Disconnector Switching in Relation to Very Fast Transients,Origin of VFTO, Propagation and Mechanism of VFTO,VFTO Characteristics,Effect of VFTO,Testing of GIS for VFTO.

Course Outcomes:

After completion of the course, the student will be able to:

- Know the Properties of SF_6
- Construction of G.I.S Substations
- Transient Phenomenon and testing of G.I.S

Text Book:

1. M.S.Naidu,"Gas Insulated Substations" I.K International publishing house Pvt.Ltd, New Delhi.

Reference Books:

1. O.Kindsen&K.V.Menon, " Future developments trend in GIS Technology" 3rd workshop & conference on EHV Technology, Indian Institute of Science, Bangalore, August 2-4, 1995.
2. V.N.Maller and M.S.Naidu "Advances in High Voltage Insulation & Arc Interruption in SF6 and Vaccum", Pergamon Press, Oxford, 1982.

PULSE POWER ENGINEERING

(Common to, HVE, PSHVE)

(Elective-III)

Prerequisites: Basic concepts of Pulse forming networks and energy storage devices

Course Educational Objectives:

- To know the static and dynamic breakdown strength of dielectric materials and various switches
- To know the energy storage device like Marx generator, inductive energy storage, rotor and homo polar generators, fly wheels.
- To know the design of pulse forming networks in transmission lines and power and voltage adding.

UNIT1: **Static and Dynamic Breakdown Strength of dielectric Materials**

Introduction-Gases-static breakdown-pulsed breakdown-spark formation-liquids-basic electrical Process-steamer breakdown-practical considerations-solids-General observations-charge Transport, injection and Breakdown-statistical Interpretation of breakdown Strength Measurements

UNIT2: Energy Storage

Pulse Discharge Capacitors-Marx Generators-classical Marx generators-LC Marx Generator-Basic Pulsed-Power Energy Transfer Stage-inductive energy storage-power and voltage multiplication-rotors and homo polar Generators

UNIT3: **Switches**

Closing switches-gas switches-semi conductor closing switches-magnetic switches-summary-opening switches-fuses-mechanical interrupters-superconducting opening switches-plasma opening switches-plasma flow switches-semiconductor opening switches

UNIT 4: Pulse forming networks:

Transmission lines-terminations and junctions-transmission lines with losses-the finite transmission line as a circuit element-production of pulses with lossless transmission lines-RLC networks-circuit simulation with LEITER

Power and Voltage Adding: Adding of Power-Voltage Adding-voltage adding by transit-time Isolation- voltage adding by Inductive Isolation-Blumlein Generators-Cumulative Pulse Lines

UNIT5: Examples of Pulsed-power Generators:

Single-pulse generators: KALIF-PBFA 2 and the Z-Machine- HERMES III

Repetitive Generators: RHEPP and Generators with opening switches

Course Outcomes:

After completion of the course, student will able to know

- Various energy storage devices, repetitive generators and cumulative pulse lines.
- Pulse forming networks and their applications.
- Pulse power generators.

Reference Books:

1. Pulsed Power Engineering by Professor Dr.HasjoachimBluhm.
2. Explosive Pulsed Power -L. L. Altgilbers, J. Baird, B. Freeman, C. S. Lynch, and S. I. Shkuratov -Imperial College Press.
3. Advances in Pulsed Power Technology, Vol. 1 & 2, Plenum Press.
4. Pulsed Power Systems: Principles and Applications-Dr.HasjoachimBluhm-Springer

I Year - II Semester

L	P	C
4	0	3

FLEXIBLE AC TRANSMISSION SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS)

(Elective- IV)

Prerequisites: Concepts on Power Electronics and Power Systems

Course Educational Objectives:

- To study the performance improvements of transmission system with FACTS.
- To study the effect of static shunt compensation.
- To study the effect of static series compensation.
- To study the effect of UPFC.

UNIT 1 : FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT 2 : Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.
Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.

UNIT 3 :SVC and STATCOM : The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT 4 : Static series compensators : Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

UNIT 5 : Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparision of the UPFC to series compensators and phase angle regulators.

Course Outcomes:

After completion of the course, the student will be able to :

- Able to know the performance improvement of transmission system with FACTS.
- Able to get the knowledge of effect of static shunt and series compensation.
- Able to know the effect of UPFC.
- Able to determine an appropriate FACTS device for different types of applications.

ReferenceBooks :

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available -Standard Publications
2. Sang.Y.Hand John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
3. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

POWER SYSTEM DEREGULATION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS)

(Elective -IV)

Prerequisites: Knowledge onPower systems

Course Educational Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

UNIT 1

Need and conditions for deregulation. Introduction of Market structure, MarketArchitecture, Spot market, forward markets and settlements.Review ofConcepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

UNIT 2

Electricity sector structures and Ownership /management, the forms of Ownership and management.Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

UNIT 3

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

UNIT 4

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing.Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

UNIT 5

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Corse Outcomes:

After completion of the course, the student will be able to:

- Understand of operation of deregulated electricity market systems
- Typical issues in electricity markets
- To analyze various types of electricity market operational and control issues using new mathematical models.

Reference Books:

1. Power System Economics: Designing markets for electricity - S. Stoft
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg
3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder
4. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li
5. Fundamentals of power system economics - S. Kirschen and G. Strbac
6. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau
7. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

REACTIVE POWER COMPENSATION & MANAGEMENT

(Common to HVE, PSHVE, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective- IV)

Prerequisites: Brief idea of power system analysis, electric traction systems and Arc furnaces

Course Educational Objectives:

- To know the basic objectives of reactive power compensation.
- To know the types of compensation and their behavior.
- To know the mathematical modeling of reactive power compensating devices.
- To know the reactive power compensation has to be done at distribution side.
- To know the role of reactive power compensation at electric traction systems and Arc furnaces.

UNIT -1:Load Compensation

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT -2: Reactive power compensation in transmission system:

Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT -3:Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT -4:Distribution side Reactive power Management:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

User side reactive power management:

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-5: Reactive power management in electric traction systems and are furnaces:

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Course Outcomes: After completion of the course the student will be able to

- Learn various load compensations.
- Obtain the mathematical model of reactive power compensating devices.
- Get application of reactive power compensation in electrical traction & arc furnaces.

Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

I Year - II Semester

L	P	C
0	4	2

SIMULATION LABORATORY

(Common to HVE, PSHVE)

Course Educational Objectives: To understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.

List of Experiments:

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Load Flow Solution UsingFast Decoupled Method
5. Formation of Z-Bus by Z-bus building algorithm
6. Symmetrical Fault analysis using Z-bus
7. Unsymmetrical Fault analysis using Z-bus
8. Economic Load Dispatch with & without transmission losses
9. Transient Stability Analysis Using Point By Point Method
10. Load Frequency Control of Single Area Control& Two Area Control system with and without controllers.

Course Outcomes: After the completion of the lab they will verify the theoretical concepts of various aspects of Power System analysis.

II Year - III Semester

L	P	C
0	0	2

COMPREHENSIVE VIVA-VOCE

II Year - III Semester

L	P	C
0	0	2

SEMINAR - I

II Year - III Semester

L	P	C
0	0	16

PROJECT WORK PART - I

II Year - IV Semester

L	P	C
0	0	2

SEMINAR - II

II Year - IV Semester

L	P	C
0	0	18

PROJECT WORK PART - II

ACADEMIC REGULATIONS & COURSE STRUCTURE

For

POWER ELECTRONICS (PE)
POWER AND INDUSTRIAL DRIVES (P&ID)
POWER ELECTRONICS AND ELECTRICALDRIVES (PE &ED)
POWER ELECTRONICS AND DRIVES (PE&D)
POWER ELECTRONICS AND SYSTEMS (PE&S)
ELECTRICAL MACHINES AND DRIVES (EM&D)

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Semester

S. No.	Subject	L	P	Credits
1	Electrical Machine Modeling & Analysis	4	--	3
2	Analysis of Power Electronic Converters	4	--	3
3	Power Electronic Control of DC Drives	4	--	3
4	Flexible AC Transmission Systems	4	--	3
5	**Elective – I** i. Modern Control Theory ii. Power Quality ii. Optimization Techniques	4	--	3
6	**Elective – II** i. Energy Auditing, Conservation and Management ii. Artificial Intelligence Techniques iii. HVDC Transmission	4	--	3
7	Simulation Laboratory	--	4	2
Total Credits				**20**

II Semester

S. No.	Subject	L	P	Credits
1	Switched Mode Power Conversion	4	--	3
2	Power Electronic Control of AC Drives	4	--	3
3	Digital Controllers	4	--	3
4	Custom Power devices	4	--	3
5	**Elective – III** i. Renewable Energy Systems ii. Reactive Power Compensation & Management iii. Electrical Distribution Systems	4	--	3
6	**Elective – IV** i. Smart Grid Technologies ii. Special Machines iii Programmable Logic Controllers & Applications	4	--	3
7	Power Converters & Drives Laboratory	--	4	2
Total Credits				**20**

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	**--**	**--**	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				**20**

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				**20**

I Year - I Semester

L	P	C
4	0	3

ELECTRICAL MACHINE MODELING & ANALYSIS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Electrical machines & Special machines.

Course Educational Objectives:

- To know the concepts of generalized theory of electrical machines.
- To represent the DC and AC machines as Basic Two Pole machine.
- To model the electrical machines with voltage, current, torque and speed equations.
- To investigate the steady state and transient behaviour of the electrical machines.
- To understand the dynamic behaviour of the AC machines.

UNIT – 1: Basic concepts of Modeling

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

UNIT – II: DC Machine Modeling

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations

UNIT- III: Reference frame theory&Modeling of single phase Induction Machines

Linear transformation-Phase transformation - three phase to two phase transformation (abc to $\alpha\beta0$) and two phase to three phase transformation $\alpha\beta0$ to abc - -Power equivalence-Mathematical modeling of single phase induction machines.

UNIT – IV: Modeling of three phase Induction Machine

Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-state space model with flux linkages as variables

UNIT –V: Modeling of Synchronous Machine& Special machines

Synchronous machine inductances –voltage equations in the rotor's dq0 reference frame-electromagnetic torque-current in terms of flux linkages-three synchronous machine model-modeling of PM Synchronous motor, modeling of BLDC motor, modeling of Switched Reluctance motor

Course Outcomes:

After completion of this course the students will be able to:

- Apply knowledge of behaviour of DC motors to model and analyse for different applications.
- Analyse the characteristics of different types of DC motors to design suitable controllers
- Apply the knowledge of reference frame theory for AC machines to model the induction andSynchronous machines.
- Evaluate the steady state and transient behaviour of induction and synchronous machines toPropose the suitability of drives for different industrial applications
- Analyse the 2-Phase induction machines using voltage and torque equations to differentiate the behaviour and to propose their applications in real world.

Reference Books:

1. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications- 1st edition -2002
2. Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press.
3. Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng-Prentice Hall
4. P.S.Bhimbra,'' Generalised theory of Electrical Machines''-Fifth edition,Khanna publishers.

I Year - I Semester

L	P	C
4	0	3

ANALYSIS OF POWER ELECTRONIC CONVERTERS
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Power switching devices, characteristics & Commutation techniques.

Course Educational Objectives:

- To study the operation of AC voltage converters and controllers.
- To study the necessity requirement of power factor correction for converter circuits.
- To study the operation of inverters with and without PWM controller.
- To study the operation of different types of multilevel inverters.

UNIT-I AC voltage Controllers

Single Phase AC Voltage Controllers with PWM control only –synchronous tap changers - Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application- numerical problems.

UNIT –II AC-DC converters

Single phase full and half Converters with inductive load– Power factor improvements: Extinction angle control-symmetrical angle control - single phase sinusoidal PWM-Single phase series converters- numerical problems - Three Phase full and half Converter with inductive load– harmonic analysis -Power factor improvements-three phase PWM-twelve pulse converters-numerical problems

UNIT-III Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

UNIT –IV PWM Inverters

single phase full bridge inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems - Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

UNIT V: Multi level inverters

Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter-Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Course Outcomes: After completion of this course the students will be able to:

- Analyze the operation of phase controlled converters and AC voltage converters.
- Analyze the requirements of power factor correction in converter circuits.
- Describe and analyse the operation of 3-phase inverters with and without PWM techniques.
- Describe principles of operation and features of multilevel inverters.

Reference books:

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley& Sons -2nd Edition.
3. Power Electronics – Lander –Ed.2009
4. Modern power Electronics and AC Drives – B.K.Bose
5. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing PvtLtd.

I Year - I Semester

L	P	C
4	0	3

POWER ELECTRONIC CONTROL OF DC DRIVES
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Power Electronics & DC Machines.

Course Educational Objectives:

- To study the operation of Phase Controlled Converters based DC drives in four quadrants.
- To study modeling concepts of AC – DC converters fed drive components.
- To study the operation of DC- DC converter fed DC drives.
- To study the operation of closed loop control based DC-DC converters fed DC drives.

UNIT-I Introduction on single phase convertor fed DC motor drive:
Basic power electronic drive system, components, stability of power electronic drive, single phase full-convertor and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using dual convertor.

UNIT-II Three phase AC-DC convertor fed DC motor drive:
Three phase full-convertor and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using three phase dual convertor. Pulsating torque

UNIT-III Modeling of AC-DC convertor fed DC drive components & design of controller:
Transfer function of Dc motor and load, convertor, current and speed controllers, current and speed feedback elements. Design of current controller and speed controller. Closed loop two quadrant DC motor drive, closed loop four quadrant DC motor drive, introduction to simulation of DC motor drive.

UNIT-IV DC-DC convertor fed DC motor drive:
Four quadrant DC-DC convertor fed dc motor drive, steady state analysis of DC-DC convertor dc motor drive, pulsating torques.

UNIT-V Closed loop operation of DC-DC convertor fed dc motor drive:
Design of current controller, design of speed controller, modeling of current and speed controller, introduction to simulation of speed controlled dc motor drive.

Course Outcomes:

After completion of this course the students will be able to:

- Analyse single phase and three phase converter fed DC drives.
- Analyse the two quadrants and four quadrant controls of DC motor drives.
- Develop the mathematical models of DC drive components.
- Analyse the four quadrant and closed loop control of DC-DC converter fed DC drive.

Reference Books:

1. Electrical Motor Drives Modeling, Analysis and Control – R. Krishna, Prentice Hall India.
2. Power Semiconductor Controlled Drives – G.K. Dubey.Prentice Hall India.
3. Power Electronics and Motor control – Shepherd, Hulley, Liang-II Edition, Cambridge University Press.
4. Power electronic circuits, devices and applications – M.H.Rashid – PHI.

I Year - I Semester

L	P	C
4	0	3

FLEXIBLE AC TRANSMISSION SYSTEMS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Concepts on Power Electronics and Power Systems

Course Educational Objectives:

- To study the performance improvements of transmission system with FACTS.
- To study the effect of static shunt compensation.
- To study the effect of static series compensation.
- To study the effect of UPFC.

UNIT 1 : FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT 2 : Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.

UNIT 3 :SVC and STATCOM : The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT 4 : Static series compensators : Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

UNIT 5 : Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators.

Course Outcomes:

After completion of the course, the student will be able to:

- Know the performance improvement of transmission system with FACTS.
- Get the knowledge of effect of static shunt and series compensation.
- Know the effect of UPFC.
- Determine an appropriate FACTS device for different types of applications.

Reference Books :

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press.
   Indian Edition is available:--Standard Publications
2. Sang.Y.Hand John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
3. HVDC & FACTS Controllers: applications of static converters in power systems-
   Vijay K.Sood- Springer publishers

I Year - I Semester

L	P	C
4	0	3

MODERN CONTROL THEORY
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES,

PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective-I)

Prerequisites: Control Systems, differential equations.

Course Educational Objectives:

- To facilitate the evolution of state variable approach for the analysis of control systems.
- To examine the importance of controllability and observability in modern control engineering.
- To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions and phase plane analysis.
- To study the analysis of stability and instability of continuous time invariant system

UNIT –1: State Variable Analysis

The concept of state – State Equations for Dynamic systems – State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

UNIT – 2: State Variable Techniques

General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems - Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.

UNIT – 3: Non Linear Systems – I

Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

UNIT – 4: Non Linear Systems – II

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT – 5: Stability Analysis

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Course Outcomes:

After completion of this course the students will be able to:

- Understanding the state variable approach is suitable for higher order.
- To analyze the concepts of controllability and observability.
- To analyze the various non-linearities through describing functions and phase plane analysis.
- Typical issues of stability and instability of continuous time invariant systems.

Reference Books :

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
4. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11^{th} Edition, Pearson Edu, India, 2009

POWER QUALITY
(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective I)

Prerequisites: Knowledge on electric circuit analysis, power systems and power electronics.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand long duration voltage variation and flicker
- To know power quality aspects in distributed generation.

UNIT-1 Introduction
Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients -Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads.

UNIT-2 Transient Over Voltages
Source of Transient Over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection - Load Switching Transient Problems - Computer Tools for Transient Analysis

UNIT-3 Harmonic Distortion and solutions
Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Nonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics

UNIT- 4 Long Duration Voltage Variations
Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application - Regulating Utility Voltage with Distributed Resources – Flicker

UNIT-5 Distributed Generation and Power Quality
Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on causes of power quality, power quality parameters.
- Understand sources of transient over voltages and providing protection to transient over voltages.
- Understand effects of harmonics, sources of harmonics and harmonic minimization.
- Analyze long duration voltage variations and regulation of voltage variations.
- Describe power quality aspects in distributed generation and develop solutions to wiring and grounding problems.

Reference Books :

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
4. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
5. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
6. Power Quality c.shankaran, CRC Press, 2001
7. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
8. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier

OPTIMIZATION TECHNIQUES
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D, PE&PS)

(Elective I)

Prerequisites: Concepts of engineering mathematics and mathematical methods.

Course Educational Objectives:

- To define an objective function and constraint functions in terms of design variables, and then state the optimization problem.
- To state single variable and multi variable optimization problems, without and with constraints.
- To explain linear programming technique to an optimization problem, define slack and surplus variables, by using Simplex method.
- To study and explain nonlinear programming techniques, unconstrained or constrained, and define exterior and interior penalty functions for optimization problems.
- To introduce evolutionary programming techniques.
- To introduce basic principles of Genetic Algorithms and Partial Swarm Optimization methods.

UNIT – I:
Introduction and Classical Optimization Techniques:
Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.
Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II:
Linear Programming
Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.

UNIT – III:
Nonlinear Programming:
Unconstrained cases - One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method - Univariate method, Powell's method and steepest descent method.
Constrained cases - Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

UNIT – IV:

Introduction to Evolutionary Methods:

Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters –Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function – constraints – Genetic algorithm steps – Stopping criteria –Simple examples.

UNIT – V:

Introduction to Swarm Intelligence Systems:

Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method – Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO.

Course Outcomes:

After completion of this course the students will be able to:

- State and formulate the optimization problem, without and with constraints, by using design variables from an engineering design problem.
- Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.
- Able to apply Genetic algorithms for simple electrical problems.
- Able to solve practical problems using PSO.

Text Books

1. "Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. Soft Computing with Matlab Programming by N.P.Padhy&S.P.Simson, Oxford University Press – 2015

Reference Books:

1. **"**Optimization methods in operations Research and Systems Analysis" by K.V.Mital and C.Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Genetic Algorithms in search, optimization, and Machine Learning by David E.Goldberg,ISBN:978-81-7758-829-3, Pearsonby Dorling Kindersley (India) Pvt. Ltd.
3. "Operations Research: An Introduction" by H.A.Taha, PHI pvt. Ltd., 6th edition.
4. Linear Programming by G.Hadley.,Narosa Publishers.

I Year - I Semester

L	P	C
4	0	3

ENERGY AUDITING, CONSERVATION&MANAGEMENT
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective II)

Perquisites: Concepts of utilization of electrical energy, electrical machines and electrical measurements.

Course Educational Objectives:

- To learn principle of energy audit as well as management for industries and utilities and buildings.
- To study the energy efficient motors and lighting.
- To learn power factor improvement methods and operation of different energy instruments.
- To compute depreciation methods of equipment for energy saving.

UNIT I: Basic Principles of Energy Audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit

UNIT II: Energy Management –I

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions, language, Questionnaire – check list for top management

UNIT III: Energy Efficient Motors and Lighting

Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics – variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit. Good lighting system design and practice, lighting control, lighting energy audit

UNIT IV: Power Factor Improvement and energy instruments

Power factor – methods of improvement , location of capacitors , Power factor with non-linear loads, effect of harmonics on p.f. , p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's

UNIT V: Economic Aspects and their computation

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present worth method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

Course Outcomes: After completion of this course the students will be able to:

- Perform energy audit in different organizations.
- Recommend energy efficient motors and design good lighting system.
- Understand advantages to improve the power factor.
- Evaluate the depreciation of equipment.

Reference Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-
3. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
4. Energy management hand book by W.C.Turner, John wiley and sons
5. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

ARTIFICIAL INTELLIGENCE TECHNIQUES
(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)
(Elective-II)

Prerequisites: Basic knowledge on human biological systems, concept of optimization and electrical engineering.

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in power electronics and DC drives.

UNIT – 1: Introduction to Neural Networks
Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

UNIT- 2:Feed Forward Neural Networks
Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks

UNIT -3: Genetic algorithms &Modelling-introduction-encoding-fitness function-reproduction operators**-**genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

UNIT – 4:Classical and Fuzzy Sets
Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.
Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

UNIT-5: Application of AI Techniques: Design of PI controller for speed control of DC motor using neural networks and fuzzy logic-PWM Controllers -Selected harmonic elimination PWM-Space vector PWM using neural network.

Course Outcomes: After completion of this course, students will be able to

- Understand neural networks and analyze different types of neural networks.
- Design training algorithms for neural networks.
- Develop algorithms using genetic algorithm for optimization.
- Analyze and designfuzzy logic systems.
- Apply AI Techniques in power electronics and DC drives.

Reference Books:

3. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan andPai – PHI Publication.
4. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
5. Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
6. Genetic Algorithms- David E Goldberg. Pearson publications.

HVDC TRANSMISSION
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective II)

Prerequisites: Knowledge on Power Electronics, Power Systems and High Voltage Engineering

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

UNIT -1: Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

UNIT-2: Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

UNIT-3 : Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.

UNIT-4 : Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT -5 : Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.
- Understand the various protection schemes of HVDC engineering.

Reference Books:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
3. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
4. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
5. Vijay K Sood :HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press.

I Year - I Semester

L	P	C
0	4	2

SIMULATION LABORATORY
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Concepts of Power Electronics & Closed loop control.

Course Educational Objectives:

- To understand the characteristics of Thyristor MOSFET & IGBT by simulation.
- To understand the operation of power electronics converters by simulation.
- To understand how to implement PWM techniques in simulation.
- To understand and analyse the speed control of AC motors in open and closed loop in simulation.

Any 10 of the following experiments are to be conducted.

List of experiments:

1. Switching characteristics simulation analysis of Thyristor, MOSFET,IGBT .
2. Simulation analysis of single phase full converter using R-L load, R-L-E load with and without LC Filter.
3. Simulation analysis of Three phase full converter using R-L-E Load.
4. Simulation analysis of single phase AC Voltage controller with PWM control for RL load.
5. Simulation analysis of three phase AC Voltage controller using RL load.
6. Simulation analysis of single phase inverter with sinusoidal PWM control forR& RL – loads.
7. Simulation analysis of Three phase inverter with Sinusoidal PWM control for R& RL - Loads.
8. Simulation analysis of Buck, Boost& Buck-Boost DC-DC converters.
9. Simulation analysis of three phase converter fed DC motor.
10. Development of mathematical model and simulation analysis of induction machines under balanced and symmetrical conditions for the following
    a. dq model in synchronous reference frame
    b. dq model in stator reference frame
    c. dq model in rotor reference frame
11. Simulation analysis of Volts/Hz closed-loop speed control of an induction motor drive.
12. Simulation analysis of Open-loop Volts/Hz control of a synchronous motor drive.
13. Simulation analysis of Speed control of a permanent magnet synchronous motor.
14. Simulation analysis of Capacitor-start capacitor-run single-phase induction motor.

COURSE OUTCOMES: After completion of this course the students will be able to:

- Analyse the characteristics of power semiconductor devices in simulation.
- Analyse the operation of various power electronic converters in simulation.
- Analyse and implementing the speed controlling techniques for AC machines in simulation.
- Analyse and implementing PWM techniques in simulation.

I Year - II Semester

L	P	C
4	0	3

SWITCHED MODE POWER CONVERSION
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D, PE&PS)

Perquisites: Concepts of electrical circuit analysis and power electronics.

Course Educational Objectives:

- To understand the control operation of non-sinusoidal DC-DC converters.
- To understand the basic operation of resonant converters.
- To understand the control operation of isolated DC-DC converters.
- To understand the control schemes of DC-DC converters and designing of magnetic components.
- To understand the modeling and control design of switch mode conversion based on linearization.
- To understand how to analyse the switch mode converters using small-signal analysis.

UNIT-I: Non-isolated switch mode converters:
Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converter, CUK Converter, Converter realization with nonideal components.

UNIT-II: Resonant converters:
Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching Quasi-resonant buck converter, zero current switching Quasi-resonant boost converter, zero voltage switching Quasi-resonant buck converter, zero voltage switching Quasi-resonant boost converter

UNIT-III: Isolated switch-mode converters:
Forwarded converter, fly back converter, Push-pull converter, half-bridge converter, full bridge converter

UNIT-IV: Control schemes of switching converters:
Voltage-mode control, Current-mode control, control scheme for resonant converters, proportional integral controller.
Magnetic design consideration: Transformers design, DC inductor and capacitor design.

UNIT-V: Modeling& Control design based on linearization:
Formulation of averaged models for buck and boost converters average circuits models, small – signal analysis and linearization.
Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode & current-mode control.

Course Outcomes:
After completion of this course the students will be able to:

- Analyse the control operation of non-isolated switch mode converters.
- Analyse the operation of resonant converters and soft switching.
- Analyse the operation of isolated switch mode converters.
- Analyse the control schemes for resonant converters and design of magnetic components.
- Analyse the design of non-isolated switch mode converters based on linearization.
- Analyse the switch mode converters with small signal analysis.

Reference Books:

1. Power Electronics – IssaBataresh, Jhonwilley publications,2004
2. Power switching converters-simonang, alejandro olive, CRC Press (Taylor &franicsgroup).
3. Elements of Power Electronics – Philip T. Krein, Oxford University press.
4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications

I Year - II Semester

L	P	C
4	0	3

POWER ELECTRONIC CONTROL OF AC DRIVES
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Perquisites: Concepts of power electronics, electrical machines and closed loopcontrol.

Course Educational Objectives:

- To analyse the VSI fed induction motor drive.
- To study the performance of different types of BLDC motor drives.
- To study different traction drives.
- To know the operation and control of switched reluctance motor & stepper motor.

UNIT-I: 3-phase induction motor drives – Part 1

Analysis of IM fed from non-sinusoidal supply, harmonic equivalent circuit, transient analysis – starting and plugging; variable frequency control, torque-slip relation, starting torque and braking torque, closed-loop VSI fed IM drive. Slip-ring IM control, closed-loop speed control with static rotor resistance, closed-loop speed control by using slip power recovery scheme.

UNIT-II: 3-phase induction motor drives – Part 2

Concept of space vector, vector control of IM: direct or feed-back vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM converter, stator flux oriented vector control, vector control of converter fed inverter drive.

UNIT-III: Synchronous motor and BLDC motor drives

Variable frequency control of synchronous motor, closed-loop control of inverter fed synchronous motor drive. Permanent magnet synchronous motor drive. BLDC motor drives, VSI fed BLDC motor drives, back emf, phase current and torque waveforms, control of BLDC motors with sensors, sensor-less control of BLDC motors

UNIT-IV: Traction drives

Motors employed in railway traction and road-vehicles, control of railway traction dc motors using ac-dc converters, control of railway traction ac motors using ac-dc and dc-ac converters, power electronic control circuits of electric vehicles and hybrid electric vehicles

UNIT-V: Switched reluctance and stepper motor drives

Switched reluctance motor operation and control: modes of operation, converter circuits closed-loop speed control. Stepper motor characteristics drive circuits for uni-polar and bipolar stepper motors.

Course Outcomes: After completion of this course the students will be able to:

- Explain operation of induction motor and analyse speed control of AC drivesbyVSIfed drives.
- Understand vector control of induction motors.
- Understand operation of traction drives.
- Analyse control schemes to synchronous motor drives.
- Understand control of switched reluctance motor & stepper motor.

Reference Books:

1. "Electric motor drives, modeling, analysis and control", R. Krishnan, PHI Publishers
2. "Control of electric drives", W. Leonhard, Springer Verilog
3. "Vector control of AC machines", ArindamGhosh, Gerard Ledwich
4. "Power Electronics: Converters,Application and design" ,Mohan, Undeland and Robbins, Wiley Publications.
5. "Urban transport and hybrid electric vehicles", Edited by SerefSoylu, Published online, 18 Aug 2010. Available:http://www.intechopen.com/books/urban-transport-and-……..
6. "Power control of AC motors", J.M.D. Murphy and F. G. Turnbul
7. "Power semiconductor drives", G. K. Dubey, Printice Hall International
8. "Fundamentals of electric drives", G. K. Dubey, Narosa Publishing House

I Year - II Semester

L	P	C
4	0	3

DIGITAL CONTROLLERS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Basic concepts of switching theory & logic design and fundamentals of micro controllers.

Course Educational Objectives:

- To understand the architecture of PIC micro controller.
- To understand the architecture of DSP processor and their interface.
- To understand how to write the program for DSP processor using assembly Programming.
- To understand the different types of FPGA and configurations.
- To understand the basics of programming in Xilinx.

UNIT- I
PIC MICROCONTROLLERS

PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)

UNIT - II
INTRODUCTION TO DSP

Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

UNIT - III
I/O & CONTROL REGISTERS

Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.

UNIT - IV
ADC & EVENT MANAGER

ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV) , Event Manager Interrupts , General Purpose (GP) Timers , Compare UNITs, Capture UNITs And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information

UNIT - V
FPGA

Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming – overview of Spartan 3E and Virtex II pro FPGA boards- case study.

Course Outcomes:
After completion of this course the students will be able to:

- Know the interfacing circuits for input and output to PIC micro controllers and DSP processors.
- Know how to write ALP for DSP processors.
- Design PWM controls for power electronic circuits using FPGA.

Reference Books:

1. Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGraw Hills
2. Microcontrollers by Kennith J ayala, Thomson publishers
3. Microprocessor and Microcontrollers by Prof C.R.Sarma.
4. Hamid.A.Toliyat and Steven G.Campbell"DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004.
5. XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998.
6. Wayne Wolf," FPGA based system design ", Prentice hall, 2004

I Year - II Semester

L	P	C
4	0	3

CUSTOM POWER DEVICES
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D, PE&PS)

Prerequisites: Concept of power electronics and concept of reactive power compensation.

Course Educational Objectives:

- To understand the various power quality issues and their effects on the distribution circuits.
- To understand principle of working of various custom power devices.
- To understand the other custom power devices and their applications to power system.

UNIT I-Introduction

Custom Power and Custom Power Devices - power quality variations in distribution circuits – Voltage Sags, Swells, and Interruptions - System Faults – Over voltages and Under voltages - Voltage Flicker - Harmonic Distortion - Voltage Notching - Transient Disturbances - Characteristics of Voltage Sags.

UNIT II-Overview of Custom Power Devices

Reactive Power and Harmonic Compensation Devices - Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices - Battery UPS – Super Conducting Magnetic Energy Storage systems - Flywheel – Voltage Source Converter - Multi-level converters.

UNIT III-Reactive Power and Harmonic Compensation Devices

Var control devices - Static Var Compensator – Topologies - Direct Connected Static Var Compensation for Distribution Systems – Static Series Compensator - Static Shunt Compensator (DSTATCOM) - Interaction with Distribution Equipment and System - Installation Considerations.

UNIT IV- High-Speed Source Transfer Switches, Solid State Limiting, And Breaking Devices:

Source Transfer Switch - Static Source Transfer Switch (SSTS),- Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker .

UNIT V-Application of Custom Power Devices in Power Systems

P-Q theory – Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control – Unified Power Quality Conditioner (UPQC) – Operation and control. Recent custom power devices.

Course Outcomes:

After completion of this course the students will be able to:

- Analyse the effect of various power quality issues in distribution system and their mitigation principles.
- Describe the operation of custom power devices for reactive power & harmonic compensation.
- Analyse high speed transfer switches.
- Analyse the operation and control of custom power devices in power system applications.

Text Books

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
2. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality, C. Shankaran, CRC Press, 2001
2. Instantaneous power theory and application to power conditioning, H. Akagiet.al., IEEE Press, 2007.
3. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002
4. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

I Year - II Semester

L	P	C
4	0	3

RENEWABLE ENERGY SYSTEMS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)
(Elective-III)

Prerequisites: Basic idea of non-conventional energy sources.

Course Educational Objectives:

- To learn basic principle of renewable energy sources.
- To adoption of alternative energy sources for power generation.
- To learn alternative energy sources not based on sun.
- To the adoption and inter connection of renewable and alternative energy sources to grid.

UNIT-1

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

UNIT-2

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy

UNIT-3

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

UNIT-4

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse.Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

UNIT-5

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifer energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

Course Outcomes:

After completion of this course the students will be able to:

- Identify alternate energy sources.
- Classify and analyze different renewable energy systems.
- Adopt different alternate energy sources for power generation.
- Adopt optimally usage of different sources and interconnection with grid.

Reference Books:

1. Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie& Beckman
5. Solar Heating and Cooling / Kreith&Kreider, CRC press.
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraw-Hill.

REACTIVE POWER COMPENSATION & MANAGEMENT
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D, HVE, PSHVE)

(Elective III)

Prerequisites: Brief idea of power system analysis, electric traction systems and Arc furnaces

Course Educational Objectives:

- To know the basic objectives of reactive power compensation.
- To know the types of compensation and their behaviour.
- To know the mathematical modeling of reactive power compensating devices.
- To know the reactive power compensation has to be done at distribution side.
- To know the role of reactive power compensation at electric traction systems and Arc furnaces.

UNIT-1:Load Compensation
Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT-2: Reactive power compensation in transmission system:
Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples
Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT -3:Reactive power coordination:
Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT -4:Distribution side Reactive power Management:
System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks
User side reactive power management:
KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-5: Reactive power management in electric traction systems and are furnaces:
Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Course Outcomes:

After completion of this course the students will be able to:

- Learn various load compensations.
- Obtain the mathematical model of reactive power compensating devices.
- Get application of reactive power compensation in electrical traction & arc furnaces.

Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

ELECTRICAL DISTRIBUTION SYSTEMS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective-III)

Prerequisites: Knowledge on basics of distribution systems, Compensation in electrical distribution systems, Circuit Analysis, concept of load modelling.

Course Educational Objectives:

- To learn the importance of economic distribution of electrical energy.
- To analyze the distribution networks for V-drops,P_{Loss}calculations and reactive power.
- To understand the co-ordination of protection devices.
- To impart knowledge of capacitive compensation/voltage control.
- To understand the principles of voltage control.

UNIT -1: (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT -2: Distribution Feeders and Substations : Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system. Location of Substations : Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.

UNIT -3 : System analysis : Voltage drop and power loss calculations : Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.

UNIT -4 : Protective devices and coordination : Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices : General coordination procedure.

UNIT -5 : Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) power factor correction, capacitor location. Economic justification.Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Course Outcomes:

After completion of this course the students will be able to:

- Analyze a distribution system.
- Design equipment for compensation of losses in the distribution system.
- Design protective systems and co-ordinate the devices.
- Understand of capacitive compensation.
- Understand of voltage control.

Reference Books:

1. "Electric Power Distribution System Engineering " byTuranGonen, Mc.Graw-Hill Book Company,1986.
2. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
3. Electrical Distribution V.Kamaraju-McGraw Hill
4. .Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

I Year - II Semester

L	P	C
4	0	3

SMART GRID TECHNOLOGIES
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)
(Elective – IV)

Prerequisites: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

UNIT 1
Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT 2
Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT 3
Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT 4
Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:

After completion of this course the students will be able to:

- Understand smart grids and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

SPECIAL MACHINES
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D)
(Elective IV)

Prerequisites: Concepts of Electrical machines.

Course Educational Objectives:

- To know the concepts of special types of electrical machines.
- To understand the different control schemes for PMSM.
- To learn about the different sensor used in brushless DC motors.
- To draw the characteristics of servo motors, tacho meters and SRM.
- To understand the concepts of linear induction motor.

UNIT I: Stepper Motors

Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

UNIT II: Permanent Magnet Synchronous Motors (PMSM) and Switched Reluctance Motors (SRM)

PMSM: Power electronic controllers, Torque speed characteristics, Self control, Vector control, Current control

SRM: Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive concept.

UNIT III: Permanent Magnet Brushless DC Motors

Concept of electronic commutation, Hall sensors, Optical sensors, back emf detection, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Speed control by microcontroller.

UNIT IV: Servomotors and AC Tachometers

Servomotor – Types – Constructional features – Principle of Operation – Characteristics - Control – Microprocessor based applications.

AC Tachometers: Permanent magnet ac tachometer, AC induction tachometer, Schematic diagrams, Operating principle.

UNIT V: Linear Motors

Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

Course Outcomes:

After completion of this course the students will be able to:

- Analyze the characteristics of different types of PM type brushless DC motors and design suitable controllers.
- Apply the knowledge of sensors used in PMSM which can be used for controllers and synchronous machines.
- Analyze the different controllers used in electrical machines to propose the suitability of drives for different industrial applications.
- Classify the types of DC linear motors and apply the knowledge of controllers to propose their application in real world.
- Evaluate the steady state and transient behavior linear induction motors.

References Books:

1. Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
2. Kenjo, T, "Stepping Motors and their Microprocessor control", Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application", Prentice Hall Inc., New Jersey,1987
4. Special Electrical Machines-K.Venkataratnam- University press
5. Floyd E Saner,"Servo Motor Applications", Pittman USA, 1993.
6. Kenjo, T and Naganori, S "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 1989.
7. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995

PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS
(Common to PE, P&ID, PE&ED, PE&D, PE&S, EM&D, PE&PS)

(Elective IV)

Prerequisites: Knowledge on relay logic and digital electronics.

Course Educational Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

UNIT 1:
PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT 2:
PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT 3:
PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT 4:
Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

UNIT 5:
Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic etc.
- Manage PLC registers for effective utilization in different applications.
- Handle data functions and control of two axis and their axis robots with PLC.
- Design PID controller with PLC.

Reference Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
3. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
4. Programmable Logic Controllers –W.Bolton-Elsevier publisher.

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I Year - II Semester

L	P	C
0	4	2

POWER CONVERTERS AND DRIVES LAB

Course Educational Objectives:

- To verify the operation of various converters and also their usage in the motor speed control application.

List of experiments

1. Analysis and speed control of DC motor drive using 3-phase full Converter.
2. Analysis of a four quadrant Chopper feeding DC motor.
3. Analysis of a 3-phase A.C. Voltage controller fed to R & RL - load.
4. Analysis of Buck, Boost, Buck-Boost DC-DC converters.
5. Analysis of Single Phase IGBT based PWM Inverter connected to R & R-L load
6. Analysis of 3-phase IGBT based PWM Inverterfeeding R & R-L load.
7. Analysis and speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
8. Analysis of three phase SVPWM Pulse generation using PIC Micro controller/DSP processor.
9. Analysis of DSP based V/F Control of 3 phase Induction motor.
10. Analysis of vector control based speed control of three phase Induction Motor drive.

Course Outcomes:

- To analyse the working of phase controlled converters, AC voltage controllers, DC-DC converters, and PWM inverters and analyse the speed control operation of power converter fed motors.

II Year - I Semester

L	P	C
0	0	2

COMPREHENSIVE VIVA-VOCE

II Year - III Semester

L	P	C
0	0	2

SEMINAR - I

II Year - III Semester

L	P	C
0	0	16

PROJECT WORK PART - I

II Year - IV Semester

L	P	C
0	0	2

SEMINAR - II

II Year - IV Semester

L	P	C
0	0	18

PROJECT WORK PART - II

ACADEMIC REGULATIONS & COURSE STRUCTURE

For

POWER ELECTRONICS & POWER SYSTEMS (PE&PS)

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Semester

S. No.	Subject	L	P	Credits
1	Analysis of Power Electronic Converters	4	--	3
2	Digital Controllers	4	--	3
3	Reactive Power Compensation & Management	4	--	3
4	HVDC Transmission	4	--	3
5	**Elective – I** i. Renewable Energy Systems ii. Artificial Intelligence Techniques iii. Modern Control Theory	4	--	3
6	**Elective – II** i. Optimization Techniques ii. Power Quality iii. Power Semiconductor Devices & Protection	4	--	3
7	Simulation Laboratory	--	4	2
Total Credits				**20**

II Semester

S. No.	Subject	L	P	Credits
1	Switched Mode Power Conversion	4	--	3
2	Custom Power devices	4	--	3
3	Advanced Power System Protection	4	--	3
4	Flexible AC Transmission Systems	4	--	3
5	**Elective – III** i. Voltage Stability ii. Power System Deregulation iii. Power System Reliability	4	--	3
6	**Elective – IV** i. Smart Grid ii. Programmable Logic Controllers & Applications iii. Energy Auditing, Conservation and Management	4	--	3
7	Power Electronics & Power Systems Laboratory	--	4	2
Total Credits				**20**

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	**--**	**--**	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				**20**

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				**20**

I Year - I Semester

L	P	C
4	0	3

ANALYSIS OF POWER ELECTRONIC CONVERTERS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Knowledge on electrical circuit analysis, electronic devices and power electronics.

Course Educational Objectives:

- To understand the control principle of ac to ac conversion with suitable power semi-conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

UNIT-1 :AC voltage Controllers

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers –Application-numerical problems

Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application-numerical problems.

UNIT –2: AC-DC converters

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems

UNIT-3: Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

UNIT –4: PWM Inverters

Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

UNIT 5: Multi level inverters

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on principle of ac voltage controller and their control techniques.
- Convert ac voltage to dc voltage and different control strategies of the converter.
- Control the power factor of single phase and three phase ac to dc converters.
- Understand the conversion of dc to ac and their control strategies.
- Analyze different multilevel inverters to improve the quality of the output voltage of the inverter.

Reference books:

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2^{nd} Edition.
3. Power Electronics – Lander –Ed.2009
4. Modern power Electronics and AC Drives – B.K.Bose
5. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing Pvt Ltd.

I Year - I Semester

L	P	C
4	0	3

DIGITAL CONTROLLERS

Prerequisites: Basic concepts of switching theory & logic design and fundamentals of micro controllers.

Course Educational Objectives:

- To understand the architecture of PIC micro controller.
- To understand the architecture of DSP processor and their interface.
- To understand how to write the program for DSP processor using assembly Programming.
- To understand the different types of FPGA and configurations.
- To understand the basics of programming in Xilinx.

UNIT- I
PIC MICROCONTROLLERS
PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)

UNIT - II
INTRODUCTION TO DSP
Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

UNIT - III
I/O & CONTROL REGISTERS
Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.

UNIT - IV
ADC & EVENT MANAGER
ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV) , Event Manager Interrupts , General Purpose (GP) Timers , Compare UNITs, Capture UNITs And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information

UNIT - V
FPGA
Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming – overview of Spartan 3E and Virtex II pro FPGA boards- case study.

Course Outcomes:
After completion of this course the students will be able to:

- Know the interfacing circuits for input and output to PIC micro controllers and DSP processors.
- Know how to write ALP for DSP processors.
- Design PWM controls for power electronic circuits using FPGA.

Reference Books:

1. Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGraw Hills
2. Microcontrollers by Kennith J ayala, Thomson publishers
3. Microprocessor and Microcontrollers by Prof C.R.Sarma.
4. Hamid.A.Toliyat and Steven G.Campbell"DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004.
5. XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998.
6. Wayne Wolf," FPGA based system design ", Prentice hall, 2004

I Year - I Semester

L	P	C
4	0	3

REACTIVE POWER COMPENSATION & MANAGEMENT

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

Prerequisites: Brief idea of power system analysis, electric traction systems and Arc furnaces

Course Educational Objectives:

- To know the basic objectives of reactive power compensation.
- To know the types of compensation and their behavior.
- To know the mathematical modeling of reactive power compensating devices.
- To know the reactive power compensation has to be done at distribution side.
- To know the role of reactive power compensation at electric traction systems and Arc furnaces.

UNIT-1:Load Compensation

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT-2: Reactive power compensation in transmission system:

Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT -3:Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT -4:Distribution side Reactive power Management:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

User side reactive power management:

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-5: Reactive power management in electric traction systems and are furnaces:

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Course Outcomes:
After completion of this course the students will be able to:

- Learn various load compensations.
- Obtain the mathematical model of reactive power compensating devices.
- Get application of reactive power compensation in electrical traction & arc furnaces.

Reference Books:
1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

I Year - I Semester

L	P	C
4	0	3

HVDC TRANSMISSION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D, HVE, PSHVE)

Prerequisites: Knowledge on Power Electronics, Power Systems and High Voltage Engineering

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

UNIT -1: Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

UNIT-2: Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

UNIT-3 : Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.

UNIT-4 : Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT -5 : Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.
- Understand the various protection schemes of HVDC engineering.

Reference Books:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
3. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
4. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
5. Vijay K Sood :HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press.

I Year - I Semester

L	P	C
4	0	3

RENEWABLE ENERGY SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

(Elective-I)

Prerequisites: Basic idea of non-conventional energy sources.

Course Educational Objectives:

- To learn basic principle of renewable energy sources.
- To adoption of alternative energy sources for power generation.
- To learn alternative energy sources not based on sun.
- To the adoption and inter connection of renewable and alternative energy sources to grid.

UNIT-1

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

UNIT-2

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of windenergy.

UNIT-3

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

UNIT-4

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse.Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

UNIT-5

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifer energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

Course Outcomes:

After completion of this course the students will be able to:

- Identify alternate energy sources.
- Classify and analyze different renewable energy systems.
- Adopt different alternate energy sources for power generation.
- Adopt optimally usage of different sources and interconnection with grid.

Reference Books :

1. Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie& Beckman
5. Solar Heating and Cooling / Kreith&Kreider, CRC press.
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraw-Hill.

I Year - I Semester

L	P	C
4	0	3

ARTIFICIAL INTELLIGENCETECHNIQUES

(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective I)

Prerequisites: Basic knowledge on human biological systems, concept of optimization and electrical engineering.

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in power electronics and DC drives.

UNIT – 1: Introduction to Neural Networks

Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

UNIT- 2: Feed Forward Neural Networks

Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks

UNIT -3: Genetic algorithms &Modelling-introduction-encoding-fitness function-reproduction operators**-**genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

UNIT – 4: Classical and Fuzzy Sets

Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.

Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

UNIT-5: Application of AI Techniques: Design of PI controller for speed control of DC motor using neural networks and fuzzy logic-PWM Controllers -Selected harmonic elimination PWM-Space vector PWM using neural network.

Course Outcomes: After completion of this course, students will be able to

- Understand neural networks and analyze different types of neural networks.
- Design training algorithms for neural networks.
- Develop algorithms using genetic algorithm for optimization.
- Analyze and designfuzzy logic systems.
- Apply AI Techniques in power electronics and DC drives.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan andPai – PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
3. Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
4. Genetic Algorithms- David E Goldberg. Pearson publications.

MODERN CONTROL THEORY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective-I)

Prerequisites: Control Systems, differential equations.

Course Educational Objectives:

- To facilitate the evolution of state variable approach for the analysis of control systems.
- To examine the importance of controllability and observability in modern control engineering.
- To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions and phase plane analysis.
- To study the analysis of stability and instability of continuous time invariant system

UNIT –1: State Variable Analysis

The concept of state – State Equations for Dynamic systems – State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

UNIT – 2: State Variable Techniques

General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems - Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.

UNIT – 3: Non Linear Systems – I

Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

UNIT – 4: Non Linear Systems – II

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT – 5: Stability Analysis

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Course Outcomes:

After completion of this course the students will be able to:

- Understanding the state variable approach is suitable for higher order.
- To analyze the concepts of controllability and observability.
- To analyze the various non-linearities through describing functions and phase plane analysis.
- Typical issues of stability and instability of continuous time invariant systems.

Reference Books :

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
4. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11^{th} Edition, Pearson Edu, India, 2009

I Year - I Semester

L	P	C
4	0	3

OPTIMIZATION TECHNIQUES

(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective II)

Prerequisites: Concepts of engineering mathematics and mathematical methods.

Course Educational Objectives:

- To define an objective function and constraint functions in terms of design variables, and then state the optimization problem.
- To state single variable and multi variable optimization problems, without and with constraints.
- To explain linear programming technique to an optimization problem, define slack and surplus variables, by using Simplex method.
- To study and explain nonlinear programming techniques, unconstrained or constrained, and define exterior and interior penalty functions for optimization problems.
- To introduce evolutionary programming techniques.
- To introduce basic principles of Genetic Algorithms and Partial Swarm Optimization methods.

UNIT – I:

Introduction and Classical Optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II:

Linear Programming

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.

UNIT – III:

Nonlinear Programming:

Unconstrained cases - One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method - Univariate method, Powell's method and steepest descent method.

Constrained cases - Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods.Introduction to convex Programming Problem.

UNIT – IV:

Introduction to Evolutionary Methods:

Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters –Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function – constraints – Genetic algorithm steps – Stopping criteria –Simple examples.

UNIT – V:

Introduction to Swarm Intelligence Systems:

Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method – Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO.

Course Outcomes:

After completion of this course the students will be able to:

- State and formulate the optimization problem, without and with constraints, by using design variables from an engineering design problem.
- Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.
- Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.
- Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.
- Able to apply Genetic algorithms for simple electrical problems.
- Able to solve practical problems using PSO.

Text Books

1. "Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. Soft Computing with Matlab Programming by N.P.Padhy&S.P.Simson, Oxford University Press – 2015

Reference Books:

1. **"**Optimization methods in operations Research and Systems Analysis" by K.V.Mital and C.Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Genetic Algorithms in search, optimization, and Machine Learning by David E.Goldberg,ISBN:978-81-7758-829-3, Pearsonby Dorling Kindersley (India) Pvt. Ltd.
3. "Operations Research: An Introduction" by H.A.Taha, PHI pvt. Ltd., 6th edition.
4. Linear Programming by G.Hadley.,Narosa Publishers.

POWER QUALITY

(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective II)

Prerequisites: Knowledge on electric circuit analysis, power systems and power electronics.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand long duration voltage variation and flicker
- To know power quality aspects in distributed generation.

UNIT-1 Introduction

Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients -Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads.

UNIT-2 Transient Over Voltages

Source of Transient Over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection - Load Switching Transient Problems - Computer Tools for Transient Analysis

UNIT-3 Harmonic Distortion and solutions

Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Nonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics

UNIT- 4 Long Duration Voltage Variations

Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application - Regulating Utility Voltage with Distributed Resources – Flicker

UNIT-5 Distributed Generation and Power Quality

Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on causes of power quality, power quality parameters.
- Understand sources of transient over voltages and providing protection to transient over voltages.
- Understand effects of harmonics, sources of harmonics and harmonic minimization.
- Analyze long duration voltage variations and regulation of voltage variations.
- Describe power quality aspects in distributed generation and develop solutions to wiring and grounding problems.

Reference Books :

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
4. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
5. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
6. Power Quality c.shankaran, CRC Press, 2001
7. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
8. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, MohammadA.S. Masoum-Elsevier

POWER SEMICONDUCTOR DEVICES & PROTECTION
(Elective- II)

Prerequisites: Concepts of power electronic devices and their characteristics.

Course Educational Objectives:

- To understand i-v characteristics of power semi-conductor devices.
- To understand switching characteristics of power semi-conductor devices.
- To understand protection & thermal management methods of power semi-conductor devices.

UNIT I: introduction to Power Devices: Introduction to power switching devices, classification of devices, controlled and un-controlled devices, i-v characteristics of ideal and real switching devices, Device structure and i-v characteristics, ratings & specifications, switching characteristics, reverse recovery, classification of various diodes: Schotky diode, line frequency diodes, fast recovery diodes,

UNIT-II: Power Transistors& MOSFET: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.
Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

UNIT-III: Power IGBT: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis,. Comparison of all the above devices with reference to power handling capability, frequency of operation, driver circuit, .emerging power switching devices.

UNIT-IV: Protection and thermal management: Device protection against over voltage/currents, di/dt and dv/dt; safe operating area, design of snubbers for power devices. Conduction and transition losses computation, thermal model of the device, steady-state temperature rise, electrical equivalent circuit of thermal model, sizing of the heat sink.

UNIT-V: Design of Passive Components: Magnetic circuit, review of design of line frequency inductors and transformers, design of high frequency inductors and transformers.

Course Outcomes:
After completion of this course the students will be able to:

- Analyse i-v characteristics of power semi-conductor devices.
- Analyse switching characteristics of power semi-conductor devices.
- Design protection circuit of power semi-conductor devices.
- Develop their model and equivalent circuits of power semi-conductor devices.
- Design line frequency & high frequency inductors and transformers for power semi-conductor devices.

Reference book:

1. Power Electronics Circuits- B. W. Williams
2.Power Electronics Circuits, Devices and Applications – M. H. Rashid-PHI-
3. Power Electronics –Converters, Applications and Design – Mohan and Undeland-John Wiley & Sons
4.Power Electronics: L. Umanand

I Year - I Semester

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SIMULATION LAB

Course Educational Objectives:

- To understand the operation of power electronic systems and their applications by the simulation.
- To understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.

Any five experiments are to be conducted from each section.

List of Experiments:

Section A: Power Electronics

1. Simulation analysis of three phase full converter using R-L-E Load.
2. Simulation analysis of three phase AC Voltage controller using RL load.
3. Simulation analysis of Buck, Boost and Buck-Boost DC-DC converters.
4. Simulation analysis of three phase converter fed DC motor.
5. Development and Simulation of 3-phase PWM Inverter with sinusoidal pulse-width modulation.
6. Simulation analysis of Volts/Hz closed-loop speed control of an induction motor drive.
7. Simulation analysis of Open-loop Volts/Hz control of a synchronous motor drive.

Section B: Power Systems

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Formation of Z-Bus by Z-bus building algorithm
5. Symmetrical Fault analysis using Z-bus
6. Unsymmetrical Fault analysis using Z-bus
7. Economic Load Dispatch with & without transmission losses

Course Outcomes:

- After the completion of the lab they will verify the theoretical concepts of various aspects of power electronic systems operation & Power System analysis.

I Year - II Semester

L	P	C
4	0	3

SWITCHED MODE POWER CONVERSION

(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Perquisites: Concepts of electrical circuit analysis and power electronics.

Course Educational Objectives:

- To understand the control operation of non-sinusoidal DC-DC converters.
- To understand the basic operation of resonant converters.
- To understand the control operation of isolated DC-DC converters.
- To understand the control schemes of DC-DC converters and designing of magnetic components.
- To understand the modeling and control design of switch mode conversion based on linearization.
- To understand how to analyse the switch mode converters using small-signal analysis.

UNIT-I: Non-isolated switch mode converters:
Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converter, CUK Converter, Converter realization with nonideal components.

UNIT-II: Resonant converters:
Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching Quasi-resonant buck converter, zero current switching Quasi-resonant boost converter, zero voltage switching Quasi-resonant buck converter, zero voltage switching Quasi-resonant boost converter

UNIT-III: Isolated switch-mode converters:
Forwarded converter, fly back converter, Push-pull converter, half-bridge converter, full bridge converter

UNIT-IV: Control schemes of switching converters:
Voltage-mode control, Current-mode control, control scheme for resonant converters, proportional integral controller.
Magnetic design consideration: Transformers design, DC inductor and capacitor design.

UNIT-V: Modeling& Control design based on linearization:
Formulation of averaged models for buck and boost converters average circuits models, small – signal analysis and linearization.
Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode & current-mode control.

Course Outcomes:
After completion of this course the students will be able to:

- Analyse the control operation of non-isolated switch mode converters.
- Analyse the operation of resonant converters and soft switching.
- Analyse the operation of isolated switch mode converters.
- Analyse the control schemes for resonant converters and design of magnetic components.
- Analyse the design of non-isolated switch mode converters based on linearization.
- Analyse the switch mode converters with small signal analysis.

Reference Books:

1. Power Electronics – IssaBataresh, Jhonwilley publications,2004
2. Power switching converters-simonang, alejandro olive, CRC Press (Taylor &franicsgroup).
3. Elements of Power Electronics – Philip T. Krein, Oxford University press.
4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications

I Year - II Semester

L	P	C
4	0	3

CUSTOM POWER DEVICES

(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Concept of power electronics and concept of reactive power compensation.

Course Educational Objectives:

- To understand the various power quality issues and their effects on the distribution circuits.
- To understand principle of working of various custom power devices.
- To understand the other custom power devices and their applications to power system.

UNIT 1-Introduction

Custom Power and Custom Power Devices - power quality variations in distribution circuits – Voltage Sags, Swells, and Interruptions - System Faults – Over voltages and Under voltages - Voltage Flicker - Harmonic Distortion - Voltage Notching - Transient Disturbances - Characteristics of Voltage Sags.

UNIT 2-Overview of Custom Power Devices

Reactive Power and Harmonic Compensation Devices - Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices - Battery UPS – Super Conducting Magnetic Energy Storage systems - Flywheel – Voltage Source Converter - Multi-level converters

UNIT 3-Reactive Power and Harmonic Compensation Devices

Var control devices - Static Var Compensator – Topologies - Direct Connected Static Var Compensation for Distribution Systems – Static Series Compensator - Static Shunt Compensator (DSTATCOM) - Interaction with Distribution Equipment and System - Installation Considerations.

UNIT 4- High-Speed Source Transfer Switches, Solid State Limiting, And Breaking Devices:

Source Transfer Switch - Static Source Transfer Switch (SSTS),- Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker

UNIT 5-Application of Custom Power Devices in Power Systems

P-Q theory – Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control – Unified Power Quality Conditioner (UPQC) – Operation and control. Recent custom power devices.

Course Outcomes: After completion of this course the students will be able to:

- Analyse the effect of various power quality issues in distribution system and their mitigation principles.
- Describe the operation of custom power devices for reactive power & harmonic compensation.
- Analyse high speed transfer switches.
- Analyse the operation and control of custom power devices in power system applications.

Text Books

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
2. **Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.**

Reference Books:

1. Power Quality, C. Shankaran, CRC Press, 2001
2. Instantaneous power theory and application to power conditioning, H. Akagiet.al., IEEE Press, 2007.
3. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002
4. **A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.**

I Year - II Semester

L	P	C
4	0	3

ADVANCED POWER SYSTEM PROTECTION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, HVE, PSHVE)

Prerequisites: Concepts of Power Electronics, Electronic circuits, STLD and basics of Relays and protection.

Course Educational Objectives:

- To learn about classification and operation of static relays.
- To understand the basic principles and application of comparators.
- To learn about static version of different types of relays.
- To understand about numerical protection techniques.

UNIT 1 : Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT 2 : Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT 3 : Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

UNIT 4 : PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT 5 : Microprocessor based relays andNumerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay.
Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Course Outcomes:

After completion of this course the students will be able to:

- Know the classifications and applications of static relays.
- Understand the application of comparators.
- Understand the static version of different types of relays.
- Understand the numerical protection techniques.

Reference Books :

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Protective Relaying Vol-II Warrington, Springer.
3. Art & Science of Protective Relaying - C R Mason, Willey.
4. Power System Stability KimbarkVol-II, Willey.
5. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.
6. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
7. Protection & Switchgear –BhaveshBhalaja,R.PMaheshwari, NileshG.Chothani-Oxford publisher

I Year - II Semester

L	P	C
4	0	3

FLEXIBLE AC TRANSMISSION SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, HVE, PSHVE)

Prerequisites: Concepts onPower Electronics and Power Systems

Course Educational Objectives:

- To study the performance improvements of transmission system with FACTS.
- To study the effect of static shunt compensation.
- To study the effect of static series compensation.
- To study the effect of UPFC.

UNIT 1 : FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT 2 : Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.

UNIT 3 :SVC and STATCOM : The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT 4 : Static series compensators : Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

UNIT 5 : Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators.

Course Outcomes:

After completion of the course, the student will be able to:

- Know the performance improvement of transmission system with FACTS.
- Get the knowledge of effect of static shunt and series compensation.
- Know the effect of UPFC.
- Determine an appropriate FACTS device for different types of applications.

Reference Books :

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press.
   Indian Edition is available:--Standard Publications
2. Sang.Y.Hand John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
3. HVDC & FACTS Controllers: applications of static converters in power systems-
   Vijay K.Sood- Springer publishers

I Year - II Semester

L	P	C
4	0	3

VOLTAGE STABILITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

(Elective III)

Prerequisites: Basic concepts of power system analysis and power factor correction.

Course Educational Objectives:

- To study the importance of voltage stability.
- To study the various load modelling in power system.
- To study the effect of reactive power compensation and voltage control.
- To study the modelling of voltage stability static indices.
- To study the voltage stability margin and its improvement.

UNIT 1 : Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power, transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis.

UNIT 2 : Power system loads : Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

UNIT 3 : Reactive Power compensation : Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

UNIT 4 : Voltage stability static indices : Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

UNIT 5 :voltage stability margins & Improvement of voltage stability: Stability margins, voltage stability margin of un compensated and compensated power system . Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

Course Outcomes:

After completion of this course the students will be able to:

- Know the importance of voltage stability.
- Determine the load modelling of power systems.
- Get the knowledge of reactive power compensation and voltage control.
- Determine the modelling of static voltage stability indices.
- Know the voltage stability margin and its improvement.

Reference Books :

1. Performance operation and control of EHV power transmission Systems A. chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.
2. Power system Voltage stability - C.W. Taylor , Mc. Graw Hill, 1994

POWER SYSTEM DEREGULATION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, HVE, PSHVE)

(Elective III)

Prerequisites: Knowledge on power systems

Course Educational Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

UNIT 1

Need and conditions for deregulation. Introduction of Market structure, MarketArchitecture, Spot market, forward markets and settlements.ReviewofConceptsmarginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

UNIT 2

Electricity sector structures and Ownership /management, the forms of Ownership and management.Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

UNIT 3

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

UNIT 4

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing.Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

UNIT 5

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Corse Outcomes:

After completion of this course the students will be able to:

- Understand of operation of deregulated electricity market systems
- Typical issues in electricity markets
- To analyze various types of electricity market operational and control issues using new mathematical models.

Reference Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.
4. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
5. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
6. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineeirng.
7. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth, Wiley.

POWER SYSTEM RELIABILITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

(Elective – III)

Prerequisites: Probability theory, power systems.

Course Educational Objectives:

- Will be able to get the basic understanding of network modelling and reliability.
- Markov chains.
- Reliability analysis of generation systems.
- Decomposition techniques.

Unit 1 : Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

Unit 2 : Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method
Reliability functions F(t), F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponentional distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

Unit 3 : Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabililties using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

Unit 4 : Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

Unit 5 : Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Course Outcomes:

After completion of this course the students will be able to:

- Understand reliability analysis applied to power systems.
- Understand Markov Chains and application to power systems.
- Perform stability analysis of generation systems.
- Understand decomposition techniques applied to power system.

Reference Books :

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Evaluation of Power System – R.Billinton, R.N.Allam, Plenum Press, New York
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition

I Year - II Semester

L	P	C
4	0	3

SMART GRID TECHNOLOGIES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective – IV)

Prerequisites: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

Unit 1

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Unit 2

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit 3

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit 4

Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

Unit 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.**Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:

After completion of this course the students will be able to:

- Understand smart grids and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS(Common to PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective IV)

Prerequisites: Knowledge on relay logic and digital electronics.

Course Educational Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

Unit 1:

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Unit 2:

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

Unit 3:

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

Unit 4:

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

Unit 5:

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic etc.
- Manage PLC registers for effective utilization in different applications.
- Handle data functions and control of two axis and their axis robots with PLC.
- Design PID controller with PLC.

Reference Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
3. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
4. Programmable Logic Controllers –W.Bolton-Elsevier publisher

ENERGY AUDITING, CONSERVATION & MANAGEMENT
(Elective IV)

Perquisites : Concepts of utilization of electrical energy, electrical machines and electrical measurements.

Course Educational Objectives:

- To learn principle of energy audit as well as management for industries and utilities and buildings.
- To study the energy efficient motors and lighting.
- To learn power factor improvement methods and operation of different energy instruments.
- To compute depreciation methods of equipment for energy saving.

Unit I: Basic Principles of Energy Audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit

Unit II: Energy Management –I

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions, language, Questionnaire – check list for top management

Unit III: Energy Efficient Motors and Lighting

Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics – variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit. Good lighting system design and practice, lighting control, lighting energy audit

Unit IV: Power Factor Improvement and energy instruments

Power factor – methods of improvement , location of capacitors , Power factor with non-linear loads, effect of harmonics on p.f. , p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's

Unit V: Economic Aspects and their computation

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present worth method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

Course Outcomes: After completion of this course the students will be able to:

- Perform energy audit in different organizations.
- Recommend energy efficient motors and design good lighting system.
- Understand advantages to improve the power factor.
- Evaluate the depreciation of equipment.

Reference Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-
3. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
4. Energy management hand book by W.C.Turner, John wiley and sons
5. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

I Year - II Semester

L	P	C
4	0	3

POWER SYSTEMS LABORATORY

Course Educational Objectives:

- To verify the operation of various converters and also their usage in the motor speed control application.
- To understand the experimental determination of various parameters used in power system area and to study the performance of transmission with & without compensation.

Any five experiments are to be conducted from each section.

List of Experiments:

Section A: Power Electronics

1. Operation of 3- phases Full-Converter on R & R-L load.
2. Performance & speed control of D.C. drive using 3-phase full Converter.
3. Performance & Operation of a four quadrant Chopper on D.C. Drive
4. Performance & Operation of a 3-phase A.C. Voltage controller on RL load.
5. Operation of 3-phase IGBT based PWM Inverter on R & R-L load.
6. Three phase PWM Pulse generation using PIC Micro controller
7. DSP based V/F Control of 3 phase Induction motor.

Section B: Power Systems

1. Determination of Sequence Impendence of an Alternator by Direct method.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of sequence impedance of a three phase transformer
   (a)by application of sequence voltage.
   (b)using fault analysis.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Poly-phase connection on three single phase transformers and measurement of phase displacement.
6. Determination of equivalent circuit of 3-winding Transformer.
7. Measurement of ABCD parameters on transmission line model.

Course Outcomes:

- To analyse the working of phase controlled converters, AC voltage controllers, DC-DC converters and PWM inverters and analyse the speed control operation of power converter fed motors.
- To understand the procedure for determination of various parameters used in power system and performance of transmission lines.

II Year - III Semester

L	P	C
0	0	2

COMPREHENSIVE VIVA-VOCE

II Year - III Semester

L	P	C
0	0	2

SEMINAR - I

II Year - III Semester

L	P	C
0	0	16

PROJECT WORK PART - I

II Year - IV Semester

L	P	C
0	0	2

SEMINAR - II

II Year - IV Semester

L	P	C
0	0	18

PROJECT WORK PART – II

ACADEMIC REGULATIONS &

COURSE STRUCTURE

For

POWER SYSTEMS (PS)
POWER SYSTEM CONTROL AND AUTOMATION (PSC&A)
POWER SYSTEM ENGINEERING (PSE)
POWER SYSTEM CONTROL (PSC)
ADVANCED POWER SYSTEMS (APS)
ELECTRICAL POWER ENGINEERING (EPE)
POWER ENGINEERING & ENERGY SYSTEMS (PE&ES)
(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

I Semester

S. No.	Subject	L	P	Credits
1	Microprocessors & Microcontrollers	4	--	3
2	HVDC Transmission	4	--	3
3	Power System Operation and Control	4	--	3
4	Reactive Power Compensation & Management	4	--	3
5	**Elective – I** i. Electrical Distribution Systems ii. EHVAC Transmission iii. Analysis of Power Electronics Converters iv. Renewable Energy Systems v. Artificial Intelligence Techniques	4	--	3
6	**Elective – II** i. Power System Security ii Advanced Digital Signal Processing iii. Generation & Measurement of High Voltages iv. Programmable Logic Controllers & Applications v. Modern Control Theory	4	--	3
7	Simulation Laboratory	--	4	2
Total Credits				**20**

II Semester

S. No.	Subject	L	P	Credits
1	Power System Dynamics and Stability	4	--	3
2	Flexible AC Transmission Systems	4	--	3
3	Real Time Control of Power Systems	4	--	3
4	Advanced Power System Protection	4	--	3
5	**Elective – III** i. Smart Grid Technologies ii. Power Quality iii. Power System Reliability iv. Voltage Stability	4	--	3
6	**Elective – IV** i. Power System Deregulation ii.High Voltage Testing Techniques iii.Power System Transients iv.Demand Side Energy Management	4	--	3
7	Power Systems Laboratory	--	4	2
Total Credits				**20**

III Semester

S. No.	Subject	L	P	Credits
1	Comprehensive Viva-Voce	**--**	**--**	2
2	Seminar – I	--	--	2
3	Project Work Part - I	--	--	16
Total Credits				**20**

IV Semester

S. No.	Subject	L	P	Credits
1	Seminar – II	--	--	2
2	Project Work Part - II	--	--	18
Total Credits				**20**

I Year - I Semester

L	P	C
4	0	3

MICROPROCESSORS &MICRO CONTROLLERS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

Prerequisites: Basic Knowledge of digital electronics, analog electronics and computers.

Course Educational Objectives:

- To learn the basic architecture of 8086.
- To learn the assembly language programming using 8086.
- To teach various peripheral devices to interface processor with different components.
- Tolearn the 8051 micro controller and its various modes of operation and its instruction set.

Unit-1: Register Organization of 8086, Architecture, Signal description of 8086, memory segmentation, addressing modes of 8086. 8086/8088 instruction set and assembler directives, machine language instruction formats, Assembly language Programs.

Unit-2: General Bus Operation, minimum mode operation of 8086 and timing diagrams, Fundamental I/O considerations, Programmed I/O, Interrupt I/O, Block transfers and DMA.

Unit-3: Introduction to stack, stack structure of 8086/8088, Interrupts and Interrupt service routine, interrupt cycle of 8086/8088. Interfacing ROM/RAM, Interfacing of I/O ports to Micro Computer System, PPI (Programmable Peripheral Interface), 8255 modes of operation, Interfacing A to D converters, Interfacing D to A converters, Interfacing Principles and stepper motor interfacing.

Unit-4: Programmable Interval timer 8254, Programmable Interrupt Controller 8259A, Key Board or Display Controller 8279, Programmable Communication Interface 8251 USART.

Unit-5: Introduction to 8051/31 Micro Controller, PIN diagram, architecture, Different modes of Operation of timer/counters, addressing modes of 8051 and instruction set. Over view of 16 bit Microcontrollers.

Course Outcomes:

Aftercompletion ofthis coursethe students will be able to:

- Understand the basic architecture of 8086.
- Develop assembly language programming using 8086.
- Understand various peripheral devices to interface processor with different components.
- Understand the 8051 micro controller and its various modes of operation and its instruction set.

Reference Books:

1. Microprocessors and Interfacing: Programming and Hardware by DouglasV. Hall, 2nd edition, TMH, New Delhi, 1999.
2. Advanced Microprocessors and Peripherals, Architecture Programming and Interfacing by A.K. Ray & K.M. Bhurchandi, Forth reprint 2004, TMH
3. The 8051Microcontrollers: Architecture, Programming & Applications by Kenneth J Ayala, Second Edition, Penram International Publishing (India).
4. Micro Computer Systems: The 8086/8088 family by YU-CHENG LIU, GLENN A.GIBSON, 2nd edition, PHI India, 2000.
5. The 8051 Microcontroller and Embedded Systems – Mohammad Ali Mazdi, Janice GillispieMazidi, Pearson Education (Singapore) Pvt. Ltd., 2003.

I Year - I Semester

L	P	C
4	0	3

HVDC TRANSMISSION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

Prerequisites: Knowledge onPower Electronics, Power Systems and High Voltage Engineering

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

Unit -1: Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

Unit-2: Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

Unit-3 : Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.

Unit-4 : Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

Unit -5 : Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes:

Aftercompletion ofthis coursethe students will be able to:

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.
- Understand the various protection schemes of HVDC engineering.

Reference Books:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
3. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
4. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
5. Vijay K Sood :HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press.

I Year - I Semester

L	P	C
4	0	3

POWER SYSTEM OPERATION AND CONTROL

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

Prerequisites: Knowledge on Power Generation Engineering, Power Transmission Engineering.

Course Educational Objectives:

- To study the unit commitment problem for economic load dispatch.
- To study the load frequency control of single area and two area systems with and without control.
- To study the effect of generation with limited energy supply.
- To study the effectiveness of interchange evaluation in interconnected power systems.

Unit-1 : Unit commitment problem and optimal power flow solution : Unit commitment : Constraints in UCP,UC solutions. Methods-priority list method, introduction to Dynamic programming Approach.

Unit-2 : Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control and Economic dispatch control.

Unit-3 : Two area Load Frequency Control : Load frequency control of 2-area system : uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment.

Unit-4 : Generation with limited Energy supply : Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.

Unit-5 : Interchange Evaluation and Power Pools Economy Interchange, Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange contracts. After-the-fact production costing, Transmission Losses in transaction Evaluation, other types of Interchange, power pools.

Course Outcomes:

Aftercompletion ofthis course the students will be able to:

- Determine the unit commitment problem for economic load dispatch.
- Get the knowledge of load frequency control of single area and two area systems with and without control.
- Know the effect of generation with limited energy supply.
- Determine the interchange evaluation in interconnected power systems.

Reference Books :

1 Modern Power System Analysis - by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.

2 Power system operation and control PSR Murthy B.S publication.

3 Power Generation, Operation and Control - by A.J.Wood and B.F.Wollenberg,Johnwiley& sons Inc. 1984.

4 Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.

5 Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

I Year - I Semester

L	P	C
4	0	3

REACTIVE POWER COMPENSATION & MANAGEMENT

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

Prerequisites: Brief idea of power system analysis, electric traction systems and Arc furnaces

Course Educational Objectives:

- To know the basic objectives of reactive power compensation.
- To know the types of compensation and their behavior.
- To know the mathematical modeling of reactive power compensating devices.
- To know the reactive power compensation has to be done at distribution side.
- To know the role of reactive power compensation at electric traction systems and Arc furnaces.

Unit-1:Load Compensation

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

Unit-2: Reactive power compensation in transmission system:

Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

Unit -3:Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

Unit -4:Distribution side Reactive power Management:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

User side reactive power management:

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

Unit-5: Reactive power management in electric traction systems and are furnaces:

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Course Outcomes:

After completion of this course the students will be able to:

- Learn various load compensations.
- Obtain the mathematical model of reactive power compensating devices.
- Get application of reactive power compensation in electrical traction & arc furnaces.

Reference Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

I Year - I Semester

L	P	C
4	0	3

ELECTRICAL DISTRIBUTION SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(ELECTIVE-I)

Prerequisites: Knowledge on basics of distribution systems, Compensation in electrical distribution systems, Circuit Analysis, concept of load modelling.

Course Educational Objectives:

- To learn the importance of economic distribution of electrical energy.
- To analyze the distribution networks for V-drops,P_{Loss}calculations and reactive power.
- To understand the co-ordination of protection devices.
- To impart knowledge of capacitive compensation/voltage control.
- To understand the principles of voltage control.

Unit -1: (Residential, Commercial, Agricultural and Industrial) and their characteristics.

Unit -2: Distribution Feeders and Substations : Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system. Location of Substations : Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.

Unit -3 : System analysis : Voltage drop and power loss calculations : Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.

Unit -4 : Protective devices and coordination : Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices : General coordination procedure.

Unit -5 : Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) power factor correction, capacitor location. Economic justification.Procedure to determine the best capacitor location. Voltage control : Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Course Outcomes:

After completion of this course the students will be able to:

- Analyze a distribution system.
- Design equipment for compensation of losses in the distribution system.
- Design protective systems and co-ordinate the devices.
- Get understanding of capacitive compensation.
- Get understanding of voltage control.

Reference Books:

1. "Electric Power Distribution System Engineering " byTuranGonen, Mc.Graw-Hill Book Company,1986.
2. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
3. Electrical Distribution V.Kamaraju-McGraw Hill
4. .Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

EHVAC TRANSMISSION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(ELECTIVE-I)

Prerequisites: Transmission line parameters and properties, Corona etc.

Course Educational Objectives:

- To calculate the transmission line parameters.
- To calculate the field effects on EHV and UHV AC lines.
- To have knowledge of corona, RI and audible noise in EHV and UHV lines.
- To have knowledge of voltage control and compensation problems in EHV and UHV transmission systems.

Unit-1:E.H.V. A.C. Transmission , line trends and preliminary aspects ,standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation.capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

Unit-2 : Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

Unit-3 : Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

Unit-4 : Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

Unit -5 : Static reactive compensating systems : Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

Course Outcomes:

After completion of this course the students will be able to:

- Calculate the transmission line parameters.
- Calculate the field effects on EHV and UHV AC lines.
- Determine the corona, RI and audible noise in EHV and UHV lines.
- Analyze voltage control and compensation problems in EHV and UHV transmission systems.

Reference Books :

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

ANALYSIS OF POWER ELECTRONIC CONVERTERS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(ELECTIVE-I)

Prerequisites: Knowledge on electrical circuit analysis, electronic devices and power electronics.

Course Educational Objectives:

- To understand the control principle of ac to ac conversion with suitable power semi conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

Unit-1 :AC voltage Controllers

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers –Application-numerical problems

Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application-numerical problems.

Unit –2: AC-DC converters

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems

Unit-3: Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

Unit –4: PWM Inverters

Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

Unit 5: Multi level inverters

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on principle of ac voltage controller and their control techniques.
- Convert ac voltage to dc voltage and different control strategies of the converter.
- Control the power factor of single phase and three phase ac to dc converters.
- Understand the conversion of dc to ac and their control strategies.
- Analyze different multilevel inverters to improve the quality of the output voltage of the inverter.

Reference books

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2nd Edition.
3. Power Electronics – Lander –Ed.2009
4. Modern power Electronics and AC Drives – B.K.Bose
5. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing Pvt Ltd.

RENEWABLE ENERGY SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

(Elective-I)

Prerequisites: Basic idea of non-conventional energy sources.

Course Educational Objectives:

- To learn basic principle of renewable energy sources.
- To adoption of alternative energy sources for power generation.
- To learn alternative energy sources not based on sun.
- To the adoption and inter connection of renewable and alternative energy sources to grid.

Unit-1

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

Unit-2

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy

Unit-3

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

Unit-4

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse.Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

Unit-5

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifer energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Identify alternate energy sources.
- Classify and analyze different renewable energy systems.
- Adopt different alternate energy sources for power generation.
- Adopt optimally usage of different sources and interconnection with grid.

Reference Books :

1. Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie& Beckman
5. Solar Heating and Cooling / Kreith&Kreider, CRC press.
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraw-Hill.

ARTIFICIAL INTELLIGENCE TECHNIQUES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

(Elective-I)

Prerequisites: Basic knowledge on human biological systems, concept of optimization and electrical engineering.

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in electrical engineering.

Unit – 1: Introduction to Neural Networks

Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

Unit- 2:Feed Forward Neural Networks

Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feedforward recall and error back propagation training-Radial basis function algorithms-Hope field networks

Unit -3: Genetic algorithms &Modelling-introduction-encoding-fitness function-reproduction operators**-**genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

Unit – 4:Classical and Fuzzy Sets

Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions.

Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

Unit 5: Application of AI Techniques-load forecasting-load flow studies-economic load dispatch-load frequency control-reactive power control-speed control of dc and ac motors

Course Outcomes:

After completion of this course the students will be able to:

- Understand neural networks and analyze different types of neural networks.
- Design training algorithms for neural networks.
- Develop algorithms using genetic algorithm for optimization.
- Analyze and designfuzzy logic systems.
- Apply AI Techniques in electrical engineering.

Reference Books :

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.

I Year - I Semester

L	P	C
4	0	3

POWER SYSTEM SECURITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(ELECTIVE II)

Prerequisites: Basic knowledge of measurements in power systems.

Course Educational Objectives:

- To study the short circuit analysis of balanced and unbalanced power systems.
- To study the power system security analysis.
- To study the real time control of power system.
- To study the principles and applications of SCADA.

Unit-1: Short circuit analysis techniques in AC power Systems- Simulation of short circuit and open circuit faults using network theorems- fixed impedance short circuit analysis techniques-time domain short circuit analysis in large scale power systems- analysis of time variation of AC and DC short circuit components

Unit-2: Fixed impedance Short circuit analysis of large scale power systems-general analysis of balanced, unbalanced and open circuit faults- 3-phase short circuit analysis in large scale power systems, Network equivalents and practical short circuit current assessments in large scale Ac power systems-general studies- uncertainties in short circuit current calculations-probabilistic Short circuit analysis

Unit-3: Risk assessment and safety considerations-control and limitation of high short circuit currents-limitation of short circuit currents in power system operation, design and planning, Types of short circuit fault current limiters- earthing resistor or reactor connected to transformer neutral-pyrotechnic fault current limiters- series resonant current limiters- saturable reactor limiters-other types of fault current limiters and their applications.

Unit-4: Power System Securityanalysis- concept of security- security analysis and monitoring-factors affecting power system security- detection of network problems –overview, contingency analysis for generator and line outages by ILPF method – fast decoupled inverse Lemma-based approach, network sensitivity factors –contingency selection –concentric relaxation and bounding.

Unit-5: Computer control power systems – need for real time and computer control of power systems- operating states of power system – SCADA- implementation considerations – software requirements for implementing above functions.

Course Outcomes:

After completion of this course the students will be able to:

- Analyze the balanced and unbalanced power system under short circuit conditions.
- Understand how to minimize the short circuit effect on the power System.
- Design the power system with more security with real time control.
- Implant SCADA for power system security.

Reference Books:

1.Allen J. Wood and Bruce Woolenberg: Power System Generation, Operation and Control ,John Willey and sons,1996

2.John J.Grainger and William D Stevenson Jr.: Power System analysis,McGraw Hill,ISE,1994.

3.Nasser D.Tleis : Power System Modelling and fault analysis, Elsevier, 2008.

4. Hand book of Power Systems, GrigsBee.,CRC Press ,Newyork.

ADVANCED DIGITAL SIGNAL PROCESSING

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

(Elective II)

Prerequisites: Knowledge on signal processing and Z-transform.

Course Educational Objectives:

- To have knowledge on structures of different digital filters.
- To design digital filters with different techniques.
- To understand the implementation aspects of digital filters.
- To analyze the effect of finite word length in signal processing.
- To understand power spectrum estimation techniques in signal processing.

UNIT-1: Digital Filter Structure

Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT-2: Digital filter design

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass high pass-Band pass, and Band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean- Square-error-constrained Least-square design of FIR digital filters

UNIT-3: DSP algorithm implementation

Computation of the discrete Fourier transform- Number representation-Arithmetic operations-handling of overflow-Tunable digital filters-function approximation.

UNIT-4 : Analysis of finite Word length effects

The Quantization process and errors- Quantization of fixed -point and floating -point Numbers-Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors, Dynamic range scaling-signal- to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters-Round-off errors in FFT Algorithms.

UNIT 5: Power Spectrum Estimation

Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – parametric method for power spectrum Estimation, Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

Course Outcomes:

After completion of this course the students will be able to:

- Describe structure of digital filters.
- Design digital filters with different techniques.
- Understand the implementation aspects of signal processing algorithms.
- Know the effect of finite word length in signal processing.
- Analyze different power spectrum estimation techniques.

Reference Books:

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
3 Digital Signal Processing principles, algorithms and Applications – John G.Proakis -PHI –3rd edition-2002
4. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
5. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold
6. Digital Filter Analysis and Design-Auntonian-TMH

GENERATION & MEASUREMENTS OF HIGHVOLTAGES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)

(Elective II)

Prerequisites: Basics of Electrical circuits, Electronics and measurements for testing purpose

Course Educational Objectives:

- To study the numerical methods for analyzing electrostatic field problems.
- To study the fundamental principles of generation of high voltage for testing.
- To study the methods for measurement of high AC ,DC and transient voltages.
- To Study the measurement techniques for high AC ,DC and impulse currents.

Unit 1- Electrostatic fields and field stress control : Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method.

Unit 2-Generation of High AC & DC Voltages:
Direct Voltages : AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers.
Alternating Voltages : Testing transformers-Resonant circuits and their applications, Tesla coil.

Unit 3-Generation of Impulse Voltages :
Impulse voltage specifications-Impulse generations circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.
Impulse Currents : Generation of High impulse currents and high current pulses.

Unit 4- Measurement of High AC & DC Voltages :
Measurement of High D.C. Voltages : Series resistance meters, voltage dividers and generating voltmeters.
Measurement of High A.C. Voltages : Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.

Unit 5-Measurement of Peak Voltages : Sphere gaps, uniform field gaps, rod gaps.Chubb-Fortesque methods. Passive and active rectifier circuits for voltage dividers.
Measurement of Impulse Voltages : Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.
Measurement of Impulse Currents : Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.

Course Outcomes:
Aftercompletion of this course the students will be able to:

- Understand numerical computation of electrostatic problems.
- Understand the techniques of generation of high AC, DC and transient voltages.
- Measure high AC, DC and transient voltages.
- Measure high AC, DC and transient currents.

Reference Books :

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.
3. High Voltage Technology – LL Alston, Oxford University Press 1968.
4. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.
5. Relevant I.S. and IEC Specifications.

PROGAMMABLE LOGIC CONTROLLERS & APPLICATIONS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(Elective II)

Prerequisites: Knowledge on relay logic and digital electronics.

Course Educational Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

Unit 1:

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Unit 2:

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

Unit 3:

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

Unit 4:

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

Unit 5:

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic etc.
- Manage PLC registers for effective utilization in different applications.
- Handle data functions and control of two axis and their axis robots with PLC.
- Design PID controller with PLC.

Reference Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.
3. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
4. Programmable Logic Controllers –W.Bolton-Elsevier publisher

MODERN CONTROL THEORY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(ELECTIVE-II)

Prerequisites: Control Systems, differential equations.

Course Educational Objectives:

- To facilitate the evolution of state variable approach for the analysis of control systems.
- To examine the importance of controllability and observability in modern control engineering.
- To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions and phase plane analysis.
- To study the analysis of stability and instability of continuous time invariant system

Unit –1: State Variable Analysis

The concept of state – State Equations for Dynamic systems – State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

Unit – 2: State Variable Techniques

General concept of Controllability - General concept of Observability Controllability tests for Continuous &Time Invariant systems - Observability tests for Continuous &Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.

Unit – 3: Non Linear Systems – I

Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

Unit – 4: Non Linear Systems – II

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

Unit – 5: Stability Analysis

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Course Outcomes:

After completion of this course the students will be able to:

- Understanding the state variable approach is suitable for higher order.
- To analyze the concepts of controllability and observability.
- To analyze the various non-linearities through describing functions and phase plane analysis.
- Typical issues of stability and instability of continuous time invariant systems.

Reference Books :

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
4. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11^{th} Edition, Pearson Edu, India, 2009

I Year - I Semester

L	P	C
0	4	2

SIMULATION LABORATORY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

Course Educational Objectives:

To understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.

List of Experiments:

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Load Flow Solution UsingFast Decoupled Method
5. Formation of Z-Bus by Z-bus building algorithm
6. Symmetrical Fault analysis using Z-bus
7. Unsymmetrical Fault analysis using Z-bus
8. Economic Load Dispatch with & without transmission losses
9. Transient Stability Analysis Using Point By Point Method
10. Load FrequencyControlofSingleArea Control& Two AreaControlsystem with and without controllers.

Course Outcomes:

After the completion of the lab they will verify the theoretical concepts of various aspects of Power System analysis.

I Year - II Semester

L	P	C
4	0	3

POWER SYSTEM DYNAMICS AND STABILITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

Prerequisites: Knowledge of synchronous machine, Power System Analysis

Course Educational Objectives:

- To study the model of synchronous machines.
- To study the stability studies of synchronous machines.
- To study the solution method of transient stability.
- To study the effect of different excitation systems.

Unit 1 : System Dynamics : Synchronous machine model in state space from computer representation for excitation and governor system –modeling of loads and induction machines.

Unit 2: Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eighvalue approach.

Unit 3: Digital Simulation of Transient Stability : Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques : Modified Euler method – RungeKutta method – Concept of multi machine stability.

Unit 4: Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

Unit 5: Excitation Systems : Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Able to determine the model of synchronous machines.
- Able to know the stability studies of synchronous machines.
- Able to get the knowledge of solution methods of transient stability.
- Able to know the effect of different excitation systems in power systems.

Reference Books :

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press.
3. Power systems stability and control by PRABHA KUNDUR, TMH.
4. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed. H.El.Abiad, TMH.
5. Computer Applications to Power Systems – M.A.Pai, TMH.
6. Power Systems Analysis & Stability – S.S.VadheraKhanna Publishers

I Year - II Semester

L	P	C
4	0	3

FLEXIBLE AC TRANSMISSION SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS)

Prerequisites: Concepts onPower Electronics and Power Systems

Course Educational Objectives:

- To study the performance improvements of transmission system with FACTS.
- To study the effect of static shunt compensation.
- To study the effect of static series compensation.
- To study the effect of UPFC.

Unit 1 : FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

Unit 2 : Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.

Unit 3 :SVC and STATCOM : The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

Unit 4 : Static series compensators : Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

Unit 5 : Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators.

Course Outcomes:

After completion of the course, the student will be able to:

- Know the performance improvement of transmission system with FACTS.
- Get the knowledge of effect of static shunt and series compensation.
- Know the effect of UPFC.
- Determine an appropriate FACTS device for different types of applications.

Reference Books :

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications
2. Sang.Y.H and John.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
3. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

I Year - II Semester

L	P	C
4	0	3

REAL TIME CONTROL OF POWER SYSTEMS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

Prerequisites: Power system operation and control.

Course Educational Objectives:

- To understand the importance of state estimation in power systems.
- To know the importance of security and contingency analysis.
- To understand SCADA, its objectives and its importance in power systems.
- To know the significance of voltage stability analysis.
- To know the applications of AI to power systems problems.

Unit 1 : State Estimation : Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

Unit 2 : Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

Unit 3 : Computer Control of Power Systems : Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions.

Unit 4 : Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V' curves and `Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.

Unit 5 : Application of AI and ANN in Power System : Basic concepts and definitions, algorithms for load flow, short term load forecasting, fault diagnosis and state estimation.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Understand state estimation, security and contingency evaluation.
- Understand about Supervisory control and data acquisition.
- Real time software application to state estimation.
- Understand application of AI in power system.

Reference Books :

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation and control, John Wiley & Sons, 1984
3. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
4. L.P.Singh : Advanced Power System Analysis and Dynamics, Wiley Eastern Ltd. 1986
5. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
6. P.D.Wasserman : `Neural Computing : Theory and Practice' Van Nostrand - Feinhold, New York.

I Year - II Semester

L	P	C
4	0	3

ADVANCED POWER SYSTEM PROTECTION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE, PE&PS)

Prerequisites: Concepts of Power Electronics, Electronic circuits, STLD and basics of Relays and protection.

Course Educational Objectives:

- To learn about classification and operation of static relays.
- To understand the basic principles and application of comparators.
- To learn about static version of different types of relays.
- To understand about numerical protection techniques.

Unit 1 : Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

Unit 2 : Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

Unit 3 : Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

Unit 4 : PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

Unit 5 : Microprocessor based relays andNumerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay.
Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Course Outcomes:

After completion of this course the students will be able to:

- Know the classifications and applications of static relays.
- Understand the application of comparators.
- Understand the static version of different types of relays.
- Understand the numerical protection techniques.

Reference Books :

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Protective Relaying Vol-II Warrington, Springer.
3. Art & Science of Protective Relaying - C R Mason, Willey.
4. Power System Stability KimbarkVol-II, Willey.
5. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.
6. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
7. Protection & Switchgear –BhaveshBhalaja,R.PMaheshwari, NileshG.Chothani-Oxford publisher

I Year - II Semester

L	P	C
4	0	3

SMART GRID TECHNOLOGIES

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS, PE, P&ID, PE&ED, PE&D, PE&S, EM&D)

(Elective – III)

Prerequisites: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

Unit 1

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Unit 2

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit 3

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit 4

Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

Unit 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:

After completion of this course the students will be able to:

- Understand smart grids and analyse the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyse micro grids and distributed generation systems.
- Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

POWER QUALITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(Elective III)

Prerequisites: Knowledge on electric circuit analysis, power systems and power electronics.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand long duration voltage variation and flicker
- To know power quality aspects in distributed generation.

Unit-1 Introduction

Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients -Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads.

Unit-2 Transient Over Voltages

Source of Transient Over Voltages - Principles of Over Voltage Protection - Devices for Over Voltage Protection - Utility Capacitor Switching Transients - Utility Lightning Protection - Load Switching Transient Problems - Computer Tools for Transient Analysis

Unit-3 Harmonic Distortion and solutions

Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Nonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics

Unit- 4 Long Duration Voltage Variations

Principles of Regulating the Voltage - Device for Voltage Regulation - Utility Voltage Regulator Application - Capacitor for Voltage Regulation - End-user Capacitor Application - Regulating Utility Voltage with Distributed Resources – Flicker

Unit-5 Distributed Generation and Power Quality

Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System - Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on causes of power quality, power quality parameters.
- Understand sources of transient over voltages and providing protection to transient over voltages.
- Understand effects of harmonics, sources of harmonics and harmonic minimization.
- Analyze long duration voltage variations and regulation of voltage variations.
- Describe power quality aspects in distributed generation and develop solutions to wiring and grounding problems.

Reference Books :

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
4. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
5. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
6. Power Quality c.shankaran, CRC Press, 2001
7. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis)
8. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier

POWER SYSTEM RELIABILITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES,PE&PS)

(Elective – III)

Prerequisites: Probability theory, power systems.

Course Educational Objectives:

- Will be able to get the basic understanding of network modelling and reliability.
- Markov chains.
- Reliability analysis of generation systems.
- Decomposition techniques.

Unit 1 : Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

Unit 2 : Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method
Reliability functions F(t), F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponentional distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

Unit 3 : Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabililties using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

Unit 4 : Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

Unit 5 : Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Course Outcomes:
After completion of this course the students will be able to:

- Understand reliability analysis applied to power systems.
- Understand Markov Chains and application to power systems.
- Perform stability analysis of generation systems.
- Understand decomposition techniques applied to power system.

Reference Books :

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Evaluation of Power System – R.Billinton, R.N.Allam, Plenum Press, New York
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition

VOLTAGE STABILITY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, PE&PS)

(Elective III)

Prerequisites: Basic concepts of power system analysis and power factor correction.

Course Educational Objectives:

- To study the importance of voltage stability.
- To study the various load modelling in power system.
- To study the effect of reactive power compensation and voltage control.
- To study the modelling of voltage stability static indices.
- To study the voltage stability margin and its improvement.

Unit 1 : Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power, transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis.

Unit 2 : Power system loads : Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

Unit 3 : Reactive Power compensation : Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

Unit 4 : Voltage stability static indices : Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

Unit 5 :voltage stability margins & Improvement of voltage stability: Stability margins, voltage stability margin of un compensated and compensated power system . Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Know the importance of voltage stability.
- Determine the load modelling of power systems.
- Get the knowledge of reactive power compensation and voltage control.
- Determine the modelling of static voltage stability indices.
- Know the voltage stability margin and its improvement.

Reference Books :

3. Performance operation and control of EHV power transmission Systems A. chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.
4. Power system Voltage stability - C.W. Taylor , Mc. Graw Hill, 1994

I Year - II Semester

L	P	C
4	0	3

POWER SYSTEM DEREGULATION

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE PE&PS)

(Elective IV)

Prerequisites: Knowledge on power systems

Course Educational Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

Unit 1

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

Unit 2

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Unit 3

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

Unit 4

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

Unit 5

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Understand of operation of deregulated electricity market systems
- Typical issues in electricity markets
- To analyze various types of electricity market operational and control issues using new mathematical models.

Reference Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.
4. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
5. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
6. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineeirng.
7. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth, Wiley.

HIGH VOLTAGE TESTING TECHNIQUES
(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES, HVE, PSHVE)
(Elective IV)

Prerequisites: Basics of high voltage engineering.

Course Educational Objectives:

- To understand non destructive testing methods.
- To understand commercial and technical testing of different HV power applications.

Unit 1 : Non Destructive Testing Techniques : Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors.

Unit 2 : High Voltage Testing of Power Apparatus : Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests – Tests for cap and pin porcelain/Glass insulators.

Unit 3 : High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables. Artificial Contamination Tests : Contamination flashover phenomena-Contamination Severity-Artificial contamination tests-Laboratory Testing versus in-Service Performance-Case study.

Unit 4 : Impulse Testing : Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.

Unit 5 : Partial Discharge Measurement : PD equivalent model-PD currents-PD measuring circuits-Straight and balanced detectors-Location and estimation of PD in power apparatus-PD measurement by non electrical methods-Calibration of PD detectors. RIV Measurements : Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Understand different testing procedures on electrical a) Insulating materials
  b) Insulation Systems.c) Power apparatus.
- Learn the different testing techniques adopted on electrical power apparatus.

Reference Books :

1. High Voltage Engineering – by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw Hill Publishing Company Limited, New Delhi – 2001.
3. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
4. Hyltencavallius. N. High voltage laboratory planning EnileHaefely&Co. Ltd. Based Switzerland 1988
5. Ryan H.M. and Whiskand: design and operation perspective of British UHV Lab IEE pre 133 H.V. Testing Techniques Halfly

POWER SYSTEM TRANSIENTS

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(Elective IV)

Prerequisites: This course required knowledge of circuit transients, symmetrical components, fault analysis and lightning.

Course Educational Objectives:

- To study the effect of over voltages on power system.
- To study the techniques of travelling wave on transmission lines.
- To study the effect of lightning and switching transients on power systems.

Unit 1 : Basic Concepts and Simple Switching Transients;- Switching an LR,LC,RLC circuits Transients Analysis of Three-Phase power Systems: – Symmetrical components inthree-phase Systems, Sequence Components for Unbalanced Network Impedances, the Sequence Networks, analysis of Unsymmetrical Three-Phase Faults-single line-to-Ground Fault, Three phase-to-ground fault.

Unit 2 : Travelling Waves:- Velocity of Travelling waves and Characteristic Impedance, Energy Contents of Travelling Waves, Attenuation and Distortion of Electromagnetic Waves, telegraph equations-lossless line, distortion less line, Reflection and Refraction of Travelling Waves, Reflection of Travelling Waves against Transformer-and-Generator-windings, the Origin Transient Recovery voltages, bewley-lattice diagram. travelling waves and multi conductor system.

Unit 3 :Switching Transients:- arc interruption in circuit breaker , transient recovery voltage, arc-circuit interaction, interruption of capacitive currents, interruption of inverse currents, interruption of fault current in transmission line and transformers.

Unit 4 : Power System Transient Recovery Voltages:-Characteristics of the Transient Voltage- Short-circuit test duties based on IEC 60056 (1987),ANSI/IEEE Standards, the Harmonization between IEC and ANSI/IEEE Standards with respect to Short-circuit Test duties, transient recovery voltage for Different types of faults.

Unit 5 : Lightning –Induced Transients:-Mechanism of Lightning, wave shape of the lightning current, Direct lighting Stroke to transmission line towers, direct lightening stroke to a line, lightning protection scheme. Numerical simulation of electrical transients, The Electromagnetic Transient Program, principles of numerical techniques used in transient simulation.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Understand the severity of over voltages due to faults on a given power system.
- To limit the effects of lightning over voltages in power systems.
- Understand the various transient over voltages and their effects on power system.

Reference Books :

1. Electrical Transients in Power System by Allen Greenwood, McGraw Hill 1990
2. Power system grounding & transients by A.P.SakisMeliopolous.
3. "Transients in power systems" by Lou Van Sluis
4. Bewley LV "travelling waves on transmission system" Dover publications Inc.,
5. Walter Diesendorf, Insulation co-ordination in high-voltage electric power systems, Butterworths, London, (1974),
6. J. G. Anderson: EHV Transmission Line Reference Book (Edison Electric Institute, New York, 1968) p. 126.

DEMAND SIDE ENERGY MANAGEMENT

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

(Elective IV)

Prerequisites: Students require concepts on utilization of electrical energy.

Course Educational Objectives:

- To know the energy audit principles in power system.
- To know the energy economics associated with consumption of energy.
- To know the energy conservation in electric utility and industry.
- To know the lighting schemes and methods to conserve the energy.
- To understand the energy conservation aspect in space heating, ventilation, air Condition etc.

Unit-1 : Energy Audit and Energy management information systems: Energy audit: Definitions-Need-concepts-Types of energy audit; Energy management information systems: Introduction-Need-components-designing-using the system-identifying plant outages

Unit-2 : Energy Economics: Introduction-Cost benefit risk analysis-Payback period-Straight line depreciation-Sinking fund depreciation—Reducing balance depreciation-Net present value method-Internal rate of return method-Profitability index for benefit cost ratio.

Unit-3 : Energy Conservation in Electric utilities and Industry: Electrical load management: Energy and load management devices-Conservation strategies; conservation in electric utilities and industry: Introduction-Energy conservation in utilities by improving load factor-Utility voltage regulation-Energy conservation in Industries-Power factor improvement.

Energy –efficient electric motors: Energy efficient motors-construction and technical features-case studies of EEMs with respect to cost effectiveness-performance characteristics; Economics of EEMs and system: life cycle-direct savings and payback analysis-efficiency factor or efficiency evaluation factor

Unit-4 : Electric Lighting: Introduction-Need for an energy management program-Building analysis-Modification of existing systems-Replacement of existing systems-priorities:
Illumination requirement : Task lighting requirements-lighting levels-system modifications-non illumination modifications-lighting for non task areas-reflectances-space geometry ;System elements: light sources - characteristics of families of lamps-lamp substitution in an existing systems-selection of Higher efficiency lamps for a new system-Luminaries-ballasts-energy conservation in lighting.

Unit-5 : Space Heating ,Ventilation, Air-Conditioning(HVAC) and Water Heating: Introduction-Heating of buildings-Transfer of Heat-Space heating methods-Ventilation and air-conditioning-Insulation-Cooling load-Electric water heating systems-Energy conservation methods.

Co-generation and storage: Combined cycle cogeneration-energy storage: pumped hydro schemes-compressed air energy storage(CAES)-storage batteries-superconducting magnetic energy storage (SMES).

Course Outcomes:

After completion of this course the students will be able to:

- Understand the principles and application of energy audit.
- Understand energy economics in utility systems.
- Understand the principle of energy conservation in lightning schemes.
- Apply energy audit principles in heating, ventilation and airconditioning etc.

Reference Books :

1.Energy management Hand book by Wayne C.Turner,Johnwiley and sons publications
2.Electric Energy Utilization and Conservation by S C Tripath, TMH publishing company ltd.New Delhi
3.Energy efficient electric motors selection and application by John C.Andreas
4.Hand book on Energy Audit and Management by AmitkumarTyagi,published by TERI(Tata energy research Institute)
5.Energy management by Paul W.O' Callaghan McGraw hill book company
6.Energy conversion systems by Rakosh Das Begamudre New age international publishers.

I Year - II Semester

L	P	C
0	4	2

POWER SYSTEMS LABORATORY

(Common to PS, PSC&A, PSE, PS&C, APS, EPE, PE&ES)

Course Educational Objectives:

To understand the experimental determination of various parameters used in power system area and to analyse the performance of transmission line with and without compensation.

List of Experiments:

1. Determination of Sequence Impendence of an Alternator by direct method.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of sequence impedance of a three phase transformer
   (a). by application of sequence voltage.
   (b). using fault analysis.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Poly-phase connection on three single phase transformers and measurement of phase displacement.
6. Determination of equivalent circuit of 3-winding Transformer.
7. Measurement of ABCD parameters on transmission line model.
8. Performance of long transmission line without compensation.
9. Study of Ferranti effect in long transmission line.
10. Performance of long transmission line with shunt compensation.

Course Outcomes:

After the Completion of lab they will understand procedure for determination of various parameters used in power system as well as performance of transmission line.

II Year - III Semester

L	P	C
0	0	2

COMPREHENSIVE VIVA-VOCE

II Year - III Semester

L	P	C
0	0	2

SEMINAR - I

II Year - III Semester

L	P	C
0	0	16

PROJECST WORK PART - I

II Year - IV Semester

L	P	C
0	0	2

SEMINAR - II

II Year - IV Semester

L	P	C
0	0	18

PROJECT WORK PART - II

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

COURSE STRUCTURE & SYLLABUS for M.Tech EEE Common for

I. Power Electronics (PE)
II. Power and Industrial Drives (P&ID)
III. Power Electronics and Electrical Drives (PE &ED)
IV. Power Electronics and Drives (PE&D)
V. Power Electronics and systems (PE&S)
VI. Electrical Machines and Drives (EM&D)

Programme

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

COURSE STRUCTURE

I Semester

S.No	Course No	Category	Course Name	P.Os	L	T	P	C	Marks
1		PC	Electrical Machine Modeling and Analysis		3	0	0	3	100
2		PC	Analysis of Power Electronic Converters		3	0	0	3	100
3		PE	Elective – I i. Modern Control Theory ii. Power Quality and Custom Power Devices iii. Programmable Logic Controllers & Applications		3	0	0	3	100
4		PE	Elective – II i. Artificial Intelligence Techniques ii. Renewable Energy Technologies iii. HVDC Transmission and Flexible AC Transmission Systems		3	0	0	3	100
5			Research Methodology and IPR		2	0	0	2	100
6			Power Electronics Simulation Laboratory		0	0	4	2	100
7			Power Converters Laboratory		0	0	4	2	100
8			Audit Course – 1		2	0	0	0	100
					16	0	8	18	800

II Semester

S.No	Course No	Category	Course Name	P.Os	L	T	P	C	Marks
1		PC	Switched Mode Power Conversion		3	0	0	3	100
2		PC	Power Electronic Control of Electrical Drives		3	0	0	3	100
3		PE	Elective – III i. Control & Integration of Renewable Energy Systems ii. Hybrid Electric Vehicles iii.Digital Control Systems		3	0	0	3	100
4		PE	Elective – IV i. Advanced Digital Signal Processing ii. Applications of Power Converters iii. Microcontrollers		3	0	0	3	100
5			Electric Drives Simulation Laboratory		0	0	4	2	100
6			Electric Drives Laboratory		0	0	4	2	100
7			Mini Project with Seminar		0	0	4	2	100
8			Audit Course – 2		2	0	0	0	100
					14	0	12	18	800

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KAKINADA – 533 003, Andhra Pradesh, India

III Semester

S.No	Course No	Category	Course Name	P.Os	L	T	P	C	Marks
1		PE	Program Elective – V i. Digital Signal Processing Controlled Drives ii. Smart Grid Technologies iii. Modeling & Simulation of Power Electronic Systems		3	0	0	3	100
2		OE	Open Elective i.Industrial Safety ii.Energy Audit, Conservation & Management iii.Composite Materials		3	0	0	3	100
3			Dissertation Phase - I **(to be continued and evaluated next semester)**		0	0	20	10	---
					6	0	20	16	200

IV Semester

S.No	Course No	Category	Course Name	T	P	C	Marks
1			Dissertation Phase-II **(continued from III semester)**	0	32	16	100
				0	32	16	100

Audit course 1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I- Semester	Electrical Machines Modeling and Analysis	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Electrical machines & Special machines.

Course Educational Objectives:

- To know the concepts of generalized theory of electrical machines.
- To represent the DC and AC machines as Basic Two Pole machine.
- To model the electrical machines with voltage, current, torque and speed equations.
- To investigate the steady state and transient behavior of the electrical machines.
- To understand the dynamic behavior of the AC machines.

UNIT– 1

Basic concepts of Modeling

Basic two-pole machine representation of Commutator machines, representations of 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine voltage, current and torque equations.

UNIT– 2

DC Machine Modeling

Mathematical model of separately excited D.C motor – Steady state analysis-transient State analysis-sudden application of inertia load-transfer function of separately excited D.C motor- Mathematical model of D.C Series motor, Shunt motor-Linearization techniques for small perturbations

UNIT– 3

Reference frame theory & Modeling of single phase Induction Machines

Linear transformation-Phase transformation - three phase to two phase transformation (abc to α β 0) and vice-versa, transformation to rotating reference frame, (α β 0 to dqo) and vice versa -Power equivalence-Mathematical modeling of single phase induction machines.

UNIT– 4

Modeling of three phase Induction Machine

Generalized model in arbitrary reference frame-Derivation of commonly used induction machine models-Synchronously rotating reference frame model, Stator reference frame model-Rotor reference frame model--power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables

UNIT– 5

Modeling of Synchronous Machine

Synchronous machine inductances –derivation of voltage equations in the rotor's dq0 reference frame electromagnetic torque-current in terms of flux linkages-three phase synchronous motor. State space models with flux linkages as variables.

Course Outcomes: At the end of the course, student will be able to

- Analyze the characteristics of different types of DC motors to design suitable controllers for different applications.
- Apply the knowledge of reference frame theory for AC machines to model the induction and Synchronous machines.
- Evaluate the steady state and transient behavior of induction and synchronous machines to propose the suitability of drives for different industrial applications
- Analyze the behavior of induction machines using voltage and torque equations.

Text Books

1. Analysis of Electric Machinery and Drive Systems, 3rd Edition-Wiley-IEEE Press- Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, Junr 2013.
2. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications.

Reference Books:

1. Generalized theory of Electrical Machines -Fifth edition, Khanna Publishers P. S. Bimbhra, 1985.
2. Dynamic simulation of Electric machinery using MATLAB / Simulink –CheeMunOng- Prentice Hall, 2003.
3. Magneto electric devices transducers, transformers and machines-G. R. Slemon- Wiley in New York, London, 1966.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Analysis of Power Electronic Converters	Category	L-T-P 3-0-0	Credits 3

Pre-Requisite: Power Electronics.

Course Educational Objectives:

- To understand the control principle of ac to ac conversion with suitable power semi - conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

UNIT– 1
Overview of Switching Devices:
Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.
UNIT– 2
AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.
UNIT– 3
Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter
UNIT– 4
PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters- Variable dc link inverter.
UNIT– 5
Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters.

Course Outcomes: At the end of the course, student will be able to

- Describe and analyze the operation of AC-DC converters.
- Analyze the operation of power factor correction converters.
- Analyze the operation of three phase inverters with PWM control.
- Study the principles of operation of multi- level inverters and their applications.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008.

Reference Books:

1. Power Electronics Daniel W. Hart - McGraw-Hill, 2011.
2. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Modern Control Theory (Elective-I)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Control Systems, differential equations.

Course Educational Objectives:

- To facilitate the evolution of state variable approach for the analysis of control systems.
- To examine the importance of controllability and observability in modern control engineering.
- To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions and phase plane analysis.
- To study the analysis of stability and instability of continuous time invariant system.

UNIT– 1

State Variable Analysis

The concept of state – State Equations for Dynamic systems– Solution of Linear Time Invariant Continuous-Time State Equations, State transition matrix and it's properties. Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model

UNIT– 2

Design using state variable technique

Design of state feedback controller through pole placement technique-Necessary and sufficient condition-Ackermann's formula. Concept of observer-Design of full order state observer-reduced order observer.

UNIT– 3

Non Linear Systems

Classification of Nonlinearities- common physical nonlinearities– Characteristics of nonlinear systems - Singular Points –Linearization of nonlinear systems– Describing function – describing function analysis of nonlinear systems- Stability analysis of Nonlinear systems through describing functions.

UNIT– 4

Stability Analysis

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of Linear Continuous time invariant systems by Lyapunov method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

UNIT– 5

Introduction to Optimal Control

Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler Lagrangine equation.

Typical optimal control performance measures-optimal control based on Quadratic performance measures- Quadratic optimal regulator systems- State regulator problems –Output regulator problems, tracking problems; Riccati equation-Infinite time regulator problem-Reduce matrix Riccati equation-determination of optimal feedback gain matrix.

Course Outcomes: At the end of the course, student will be able to

- Formulate and solve the state equations of dynamic systems, analyze controllability and observability.
- Design a state feedback controller; design an observer.
- Linearize a nonlinear system model; analyze non-linear systems through describing functions.
- Determine the stability of a given system; generate a Lyapunov function.
- Minimize a given functional, design an optimal feedback gain matrix.

Text Books:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998.
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication.

Reference Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition,1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata McGraw–Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.
6. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009

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KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Power Quality and Custom Power Devices (Elective-I)	Category	L-T-P 3-0-0	Credits 3

Pre requisite: Knowledge on electric circuit analysis, power systems and power electronics and concept of reactive power compensation techniques.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand the importance of power devices and their applications.
- To understand different compensation techniques to minimize power quality disturbances.

UNIT– 1

Introduction to power quality: Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.

UNIT– 2

Transient and Long Duration Voltage Variations: Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation

UNIT– 3

Harmonic Distortion and solutions: Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics

UNIT– 4

Custom Power Devices: Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.

UNIT– 5

Application of custom power devices in power systems: Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner

Course Outcomes: At the end of the course, student will be able to

- Identify the issues related to power quality in power systems.
- Address the problems of transient and long duration voltage variations in power systems.
- Analyze the effects of harmonics and study of different mitigation techniques.
- Identify the importance of custom power devices and their applications.
- Acquire knowledge on different compensation techniques to minimize power quality disturbances.

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis).
6. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier
7. Power Quality, C. Shankaran, CRC Press, 2001
8. Instantaneous Power Theory and Application to Power Conditioning, H. Akagiet.al., IEEE Press, 2007.
9. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002
10. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Programmable Logic Controllers & Applications (Elective-I)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Knowledge on relay logic and digital electronics.

Course Educational Objectives:

- To have knowledge on PLC.
- To acquire the knowledge on programming of PLC.
- To understand different PLC registers and their description.
- To have knowledge on data handling functions of PLC.
- To know how to handle analog signal and converting of A/D in PLC.

UNIT– 1
PLC Basics:
PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.
UNIT– 2
PLC Programming:
Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.
UNIT– 3
PLC Registers:
Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.
UNIT– 4
Data Handling functions:
SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.
UNIT– 5
Analog PLC operation:
Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Course Outcomes: At the end of the course, student will be able to

- Understand the PLCs and their I/O modules.
- Develop control algorithms to PLC using ladder logic etc.
- Manage PLC registers for effective utilization in different applications.
- Handle data functions and control of two axis and their axis robots with PLC.
- Design PID controller with PLC.

Text Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

Reference Books:

1. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.

Programmable Logic Controllers –W.Bolton-Elsevier publisher.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Artificial Intelligence Techniques (Elective-II)	Category	L-T-P 3-0-0	Credits 3

Pre –requisite: Fundamentals of Neural networks and Fuzzy Logic

Course Educational Objectives:

- To have knowledge on concept of neural network.
- To know different types of neural networks and training algorithms.
- To understand the concept of genetic algorithm and its application in optimization.
- To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
- To know the applications of AI Techniques in electrical engineering.

UNIT– 1
Introduction
Artificial Neural Networks (ANN) – definition and fundamental concepts – Biological neural networks – Artificial neuron – activation functions – setting of weights – typical architectures – biases and thresholds – learning/training laws and algorithms. Perceptron – architectures, ADALINE and MADLINE – linear separability- XOR function.

UNIT– 2
ANN Paradigms
ADALINE – feed forward networks – Back Propagation algorithm- number of hidden layers – gradient decent algorithm – Radial Basis Function (RBF) network. Kohonen'sself organizing map (SOM), Learning Vector Quantization (LVQ) and its types – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

UNIT– 3
Classical and Fuzzy Sets
Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.

UNIT– 4
FUZZY LOGIC CONTROLLER (FLC)
Fuzzy logic system components: Fuzzification, Inference engine (development of rule base and decision making system), Defuzzification to crisp sets- Defuzzification methods.

UNIT– 5
Application of AI Techniques
Speed control of DC motors using fuzzy logic –load flow studies using back propagation algorithm, single area and two area load frequency control using fuzzy logic.

Course Outcomes: At the end of the course, student will be able to

- Differentiate between Algorithmic based methods and knowledge based methods.
- Use appropriate AI framework for solving power system problems.
- To design fuzzy logic controllers for power engineering applications.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by S.Rajasekaran andG.A.VijayalakshmiPai – PHI Publication.
2. Modern power Electronics and AC Drives – B.K.Bose -Prentice Hall, 2002
3. Genetic Algorithms- David E Goldberg. Pearson publications.
5. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam,SSumathi,S N Deepa TMGH
6. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Renewable Energy Technologies (Elective-II)	Category	L-T-P 3-0-0	Credits 3

Pre requisite: UG power Electronics.

Course Educational Objectives:

- To learn technical challenges in renewable energy.
- To learn basics of wind energy conversion & PV power generation.
- To analyze the of fuel cell system.

UNIT– 1
Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power Systems

UNIT– 2
Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control.

UNIT– 3
Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation- General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system.

UNIT– 4
Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O,INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy

UNIT– 5
Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyzer Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage

Course Outcomes: At the end of the course, student will be able to

- Understand various general aspects of renewable energy systems.
- Analyze and design induction generator for power generation from wind.
- Design MPPT controller for solar power utilization.
- Utilize fuel cell systems for power generation.

Text Books:

1. Felix A. Farret, M. Godoy Simo` es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	HVDC Transmission and Flexible AC Transmission Systems (Elective-II)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Knowledge on Power Electronics, Power Systems and High Voltage Engineering

Course Educational Objectives:

- To learn various schemes of HVDC transmission.
- To learn the operation and analysis of different HVDC converter circuits.
- To learn the control of HVDC systems.
- To learn the basic types of FACTS controllers.
- To learn the series and shunt compensators.

UNIT– 1

HVDC Transmission: DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems

UNIT– 2

Analysis of HVDC Converters: Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms

UNIT– 3

HVDC Control: Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control

Harmonics and Filters: effects of Harmonics, sources of harmonic generation, Types of filters –Design examples

UNIT– 4

Power Flow Analysis in AC/DC Systems: Modelling of DC links, solutions of AC-DC Power flow

Flexible AC Transmission Systems (FACTS): FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters

UNIT– 5

Static Shunt Compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, STATCOM, basic operating principle, control approaches and characteristics

Static Series Compensators: Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power.

Course Outcomes: At the end of the course, student will be able to

- Compare HVDC and EHVAC transmission systems
- Analyze converter configurations used in HVDC and evaluate the performance metrics.
- Understand controllers for controlling the power flow through a dc link and compute filter Parameters.
- Apply impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller.
- Analyze and select a suitable FACTS controller for a given power flow condition.

Text Books:

1. NarainG.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
2. K.R.Padiyar: HVDC Power Transmission Systems –Technology and System Interactions, New Age International Publishers, 2011.

Reference Books:

1. Kimbark: Direct Current Transmission, 1971.
2. Jos Arrillaga: High Voltage Direct Current Transmission, The Institution of electrical Engineers, 1998.
3. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	Research Methodology and IPR	Category	L-T-P 2-0-0	Credits 2

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

I-Semester	POWER ELECTRONICS SIMULATION LABORATORY	CATEGORY	L-T-P 0 -0-4	CREDITS 2

Course Educational Objectives:
To analyze the operation of DC-DC converters, AC-DC converters and DC-AC converters by simulation.

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Simulation of Buck converter using small signal model.
2. Simulation of Boost converter using small signal model.
3. Simulation of single phase half bridge inverter.
4. Simulation of single-phase full bridge inverter using Uni-polar & Bi-polar PWM techniques.
5. Simulation of three phase inverter using sine-triangle PWM.
6. Simulation of three phase inverter using space vector PWM.
7. Simulation of three level three phase NPC inverter.
8. Study of neutral point voltage floating in NPC three level inverter
9. Simulation of 3-level flying capacitor inverter & evaluation of capacitor voltage balanced methods.
10. Simulation of single phase AC voltage regulator.
11. Simulation of three phase AC voltage regulator.
12. Comparison of harmonic profile of two level& three level inverter (FFT analysis).
13. Simulation of 5-level inverter using carrier based PWM methods.
14. Simulation of three phase full converter with RL & RLE loads.
15. Simulation of three-phase dual converter.

Course Outcome: To understand the operation of DC-DC converters, AC-DC converters, AC voltage regulators and DC-AC converters by simulation.

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KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	POWER CONVERTERS LABORATORY	CATEGORY	L-T-P 0 -0-4	CREDITS 2

Course Educational Objectives:
To study and understand the different converters and inverters for single and three phase loads.

Any 10 of the following experiments are to be conducted.

List of experiments

1. Study of DC-DC non-isolated converters such as Buck & Boost converter.
2. Study of DC-DC Buck-Boost and Cuk converters.
3. Study of 1-ϕ dual converter.
4. Determination of input p.f. and harmonic factor for 1-ϕsemi- converter and 1-ϕ full-converter (Inductive load)
5. Study of p.f. improvement in 1-ϕ full-converter with symmetric and extinction angle control.
6. Study of 1-ϕ square wave and sinusoidal PWM inverter.
7. Study of 3-ϕ inverter with 120^o and 180^o mode of operation.
8. Study of 3-ϕ sinusoidal PWM inverter.
9. Study of 3-level NPC inverter.
10. Study of 5-level cascaded H-bridge inverter.
11. Determination of input p.f. and harmonic factor for 3-ϕ full converter (Inductive load).
12. Determination of input p.f. and harmonic factor for 3-ϕ semi converter (Inductive load).
13. Study the characteristics of IGBT, MOSFET & GTO's.
14. Design of gate drive circuits for IGBT & MOSFET's.

Course Outcomes: Students are able to implement the converter and inverters in real time applications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I-Semester	**Audit Course-1**	**PC**	**L-T-P 2-0-0**	**Credits 0**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Switched Mode Power Conversion	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Concepts of electrical circuit analysis and power electronics.

Course Educational Objectives:

- To understand the control operation of non-sinusoidal DC-DC converters.
- To understand the basic operation of resonant converters.
- To understand the control operation of isolated DC-DC converters.
- To understand the control schemes of DC-DC converters and designing of magnetic components.
- To understand the modeling and control design of switch mode conversion based on linearization.
- To understand how to analyze the switch mode converters using small-signal analysis.

UNIT– 1
Non-isolated switch mode converters:
Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, Converter realization with non-ideal components.
UNIT– 2
Isolated switched mode converters:
Forwarded converter, flyback converter, push-pull converter, half-bridge converter, full bridge converter.
UNIT– 3
Resonant converters:
Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter.
UNIT– 4
Control schemes of switching converters:
Voltage control, Current mode control, control scheme for resonant converters.
Magnetic design consideration: Transformer design, inductor and capacitor design.
UNIT– 5
Modeling and Controller design based on linearization:
Formulation of averaged models for buck and boost converters:state space analysis, average circuit models, linearization and small – signal analysis, small-signal models.
Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.

Course Outcomes: At the end of the course, student will be able to

- Analyze operation and control of non-isolated and isolated switch mode converters.
- Design of non-isolated and isolated switch mode converters.
- Analyze operation and control of resonant converters.
- Feedback design of switch mode converters based on linearized models.

Text Books:

1. Fundamentals of Power Electronics-Erickson, Robert W., Maksimovic, Dragan, Springer, 2011.
2. Power switching converters-Simon Ang, Alejandro Oliva, CRC Press, 2010.
3. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
4. Design of Magnetic Components for Switched Mode Power Converters- Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992.

Reference Books:

1. Power Electronics: Essentials and applications- L. Umanand, Wiley publications
2. Switching Power Supply Design-Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 1991.
3. Power Electronics – IssaBatareseh, Jhon Wiley publications, 2004.
4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Power Electronic Control of Electrical Drives	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Knowledge of Power Electronics and Electrical Machines.

Course Educational Objectives:

- To familiarize with advanced control schemes for induction motor drives and control techniques for PMSM, BLDC and SRM drives.

UNIT– 1
Vector Control of Induction Motor Drive:
Principle of scalar and vector control, direct vector control, indirect vector control, rotor flux oriented control, stator flux oriented control, air gap flux oriented control, decoupling circuits.
UNIT– 2
Sensor less Control of induction Motor Drive:
Advantages of speed sensor less control, voltage current based speed sensor less control, MRAS-model reference adaptive systems, Extended Kalman filter observers.
UNIT– 3
Direct Torque Control of Induction Motor Drive:
Principle of Direct torque control (DTC), concept of space vectors, DTC control strategy of induction motor, comparison between vector control and DTC, applications, space vector modulation based DTC of induction motors.
UNIT– 4
Control of Permanent Magnet Synchronous Machines (PMSM) and Brushless DC (BLDC) Motor Drives:
Advantages and limitations of Permanent magnet machines, operating principle of PMSM,modeling of PMSM, operating principle of BLDC, modeling of BLDC, similarities and difference between PMSM and BLDC, need for position sensing in BLDC motors, control strategies for PMSM and BLDC, methods of reducing torque ripples of BLDC motor.
UNIT– 5
Control of Switched Reluctance Motor (SRM) Drive:
SRM structure, Merits and limitations, stator excitation, converter topologies, SRM waveforms, Torque control schemes, speed control of SRM, torque ripple minimization, instantaneous -torque control using current controllers and flux controllers.
Course Outcomes: After the completion of the course, student will be able to

- Understand the concepts of scalar and vector control methods for drive systems.
- Analyze and design controllers and converters for induction motor, PMSM and BLDC drives.
- Select and implement proper control techniques for induction motor and PMSM for specific applications.
- Analyze and design control techniques and converters for SRM drives.

Text Books:

1. Bose B. K., "Power Electronics and Variable Frequency Drives',IEEE Press, Standard Publisher Distributors. 2001.
2. Krishnan R., "Electric Motor Drives – Modeling, Analysis and Control", Prentice Hall of India Private Limited.

Reference Books:

1. Switched Reluctance Motors and Their Control-T. J. E. Miller, Magna Physics, 1993.
2. Power electronic converters applications and design-Mohan, Undeland, Robbins-Wiley publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Control & Integration of Renewable Energy Systems (Elective -III)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Power Electronics

Course Educational Objectives:

- To understand different conventional & non-conventional dynamic energy conversion technologies.
- To learn the principles of static energy conversion technologies.
- To understand the basics of real & reactive power control with renewable generators.
- To learn the principles of standalone and grid connected systems.

UNIT-1

Introduction: Electric grid introduction, Supply guarantee and power quality, Stability, Effects of renewable energy penetration into the grid, Boundaries of the actual grid configuration, Consumption models and patterns, static and dynamic energy conversion technologies, interfacing requirements .

UNIT-2

Dynamic Energy Conversion Technologies: Introduction to different conventional and nonconventional dynamic generation technologies, principle of operation and analysis of reciprocating engines, gas and micro turbines, hydro and wind based generation technologies, control and integrated operation of different dynamic energy conversion devices.

UNIT-3

Static Energy Conversion Technologies: Introduction to different conventional and nonconventional static generation technologies, principle of operation and analysis of fuel cell, photovoltaic based generators, and wind based generation technologies, different storage technologies such as batteries, fly wheels and ultra-capacitors, plug-in-hybrid vehicles, control and integrated operation of different static energy conversion devices.

UNIT-4

Real and reactive power control: Control issues and challenges in Diesel, PV, wind and fuel cell based generators, PLL, Modulation Techniques, Dimensioning of filters, Linear and nonlinear controllers, predictive controllers and adaptive controllers, Fault-ride through Capabilities, Load frequency and Voltage Control .

UNIT-5

Integration of different Energy Conversion Technologies: Resources evaluation and needs, Dimensioning integration systems, Optimized integrated systems, Interfacing requirements, integrated Control of different resources, Distributed versus Centralized Control, Synchro Converters, Grid connected and Islanding Operations, stability and protection issues, load sharing, Cases studies

Course Outcomes: After the completion of the course, student will be able to

- Gain knowledge on different renewable energy sources and storage devices
- Recognize, model and simulate different renewable energy sources
- Analyze, model and simulate basic control strategies required for grid connection
- Implement a complete system for standalone/grid connected system

Text books:

1. Ali Keyhani Mohammad Marwali and Min Dai, "Integration and Control of Renewable Energy in Electric Power System" John Wiley publishing company
2. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", IET Power Electronics Series, 2012
3. G. Masters, "Renewable and Efficient Electric Power Systems", IEEE-Wiley Publishers, 2013

References:

1. Quing-Chang Zhong, "Control of Power Inverters in Renewable Energy and Smart Grid Integration", Wiley, IEEE Press
2. Bin Wu, Yongqiang Lang, NavidZargari, "Power Conversion and Control of Wind Energy Systems", Wiley 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Hybrid Electric Vehicles (Elective-III)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Knowledge of Power Electronics and Electric Drives

Course Educational Objectives:

- To learn the concept of hybrid vehicles, types of electric drives used in hybrid vehicles and their control.

UNIT– 1
Introduction:
History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.
UNIT– 2
Hybridization of Automobile:
Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.
UNIT– 3
Plug-in Hybrid Electric Vehicle:
PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.
UNIT– 4
Power Electronics in HEVs:
Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.
UNIT– 5
Battery and Storage Systems
Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource

Course Outcomes: At the end of the course, student will be able to

- Know the concept of electric vehicles and hybrid electric vehicles.
- Familiar with different motors used for hybrid electric vehicles.
- Understand the power converters used in hybrid electric vehicles
- Know different batteries and other energy storage systems.

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction – Dhanpat Rai & Co, 2007.

Research Books:

1. Pistooa G., "Power Sources , Models, Sustanability, Infrastructure and the market", Elsevier 2008
2. Mi Chris, Masrur A., and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives" 1995.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-SEMESTER	DIGITAL CONTROL SYSTEMS (ELECTIVE-III)	CATEGORY	L-T-P 3-0-0	CREDITS 3

Pre-Requisite: Control Systems, digital control systems.

Course Educational objectives:

- To understand fundamentals of digital circuits and devices using Z-transforms and Inverse Z-Transforms
- To understand the controllability and observability in digital domain
- To understand the stability and controller design in digital domain
- To understand the design an observer
- To understand the solving of a given optimal control problem

UNIT– 1

Introduction

Introduction to analog and digital control systems – Advantages of digital systems – Typical examples– Sample and hold devices – Sampling theorem and data reconstruction-Transfer functions and frequency domain characteristics of zero order hold and first order hold. Review of Z–transforms and Inverse Z–transforms- solving differential equations. Mapping between the S–Plane and the Z–Plane – Primary strips and Complementary Strips

UNIT– 2

State space analysis and the concepts of Controllability and observability

State Space Representation of discrete time systems – State transition matrix properties and evaluation – Solution of state equations- Discretization of continuous-time state equations –controllability and observability – concepts, conditions and tests, Principle of duality.

UNIT– 3

Stability Analysis and Controller Design

Stability criterion – Modified Routh's stability criterion and Jury's stability test, Lyapunov's stability analysis.

Design of state feedback controller through pole placement techniques, Necessary and sufficient conditions, Ackermann's formula, controller for deadbeat response, control system with reference input, Design of full order observer-reduced order observer.

UNIT– 4

State Observer

Necessary and sufficient condition for state observation-Full order state observer- error dynamics – design of prediction observers- Ackermann's formula-effect of the addition of observer on closed loop system-Current observer- minimum order observer observed – state feedback control system with minimum order observer -control system with reference input.

UNIT– 5

Quadratic Optimal Control Systems

Quadratic optimal control problems-Solution by minimization method using Lagrange multipliers-Evolution of the minimum performance index – discretize quadratic optimal control –Steady state Riccati equations-Lyapunov approaches to the solution of the Steady state quadratic optimal regulator problem and optimal control problem - Quadratic optimal control of a servo system.

Course Outcomes: At the end of the course, student will be able to

- Analyze digital control systems using Z-transforms and Inverse Z-Transforms.
- Evaluate the state transition matrix and solve state equation for discrete model for continuous time systems, investigate the controllability and observability.
- Determine the stability; design state feedback controller.
- Design an observer.
- Solve a given optimal control problem.

Text Book:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. B. C. Kuo, "Digital control systems"- Holt Saunder's International Edition, 1991.

Reference Books:

1. M. Gopal: Digital control engineering**,** New Age Int. Ltd., India, 1998.
2. K. Ogata, **"**Modern control engineering"- PHI, 1991.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-semester	Advanced Digital Signal Processing (Elective-IV)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Signals & Systems

Course Educational Objectives:

- To understand the various digital filter structures
- To design the FIR and IIR Filters
- To know the importance of FFT algorithm for computation of Discrete Fourier Transform
- To analyze the finite word length effects on various filters
- To learn the concepts of power spectrum estimation of periodic and non-periodic signals

UNIT– 1
Digital Filter Structure: Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.
UNIT– 2
Digital filter design: Preliminary considerations-Bilinear transformation method of IIR filter design-design of lowpass, high pass-band pass, and band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on windowed Fourier series- design of FIR digital filters with least –mean-square-error-constrained least-square design of FIR digital filters
UNIT– 3
DSP algorithm implementation: Computation of the discrete Fourier transform- number representation-arithmetic operations handling of overflow-tunable digital filters-function approximation.
UNIT– 4
Analysis of finite Word length effects: The quantization process and errors- quantization of fixed -point and floating -point Numbers-Analysis of coefficient quantization effects, Analysis of arithmetic round-off errors, dynamic range scaling-signal- to- noise ratio in low -order IIR filters-low-sensitivity digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters, Round-off errors in FFT Algorithms.
UNIT– 5
Power Spectrum Estimation: Estimation of spectra from finite duration observations signals – Non-parametric methods for power spectrum estimation – parametric method for power spectrum estimation, estimation of spectral form-finite duration observation of signals-non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

Course Outcomes: At the end of the course, student will be able to

- Describe structure of digital filters.
- Design digital filters with different techniques.
- Understand the implementation aspects of signal processing algorithms.
- Know the effect of finite word length in signal processing.
- Analyze different power spectrum estimation techniques.

Text Books:

1. Digital signal processing-Sanjit K. Mitra-TMH second edition, 2002.
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint

Reference Books:

1. Digital Signal Processing and principles, algorithms and Applications – John G.Proakis -PHI –3rd edition-2002.
2. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
3. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold.
4. Digital Filter Analysis and Design-Auntonian-TMH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Applications of Power Converters (Elective-IV)	Category	L-T-P 3-0-0	Credits 3

Pre-requisites: Analysis of Power Electronic Converters

Course Educational Objectives:

- To understand the inverters for induction heating applications
- To understand the power converters for different industrial applications
- To understand modeling of high voltage power supplies using the power converters for radar and space applications
- To understand modeling of low voltage and high current power supplies using the power converters for microprocessors and computer loads
- To understand the applications of DC-DC converters

UNIT-1
Inverters for Induction Heating: For induction cooking, induction hardening, melting, and welding applications.
UNIT-2
Power Converters for Lighting, pumping and refrigeration Systems: Electronic ballast, LED power drivers for indoor and outdoor applications. PFC based grid fed LED drivers, PV / battery fed LED drivers. PV fed power supplies for pumping/refrigeration applications.
UNIT-3
High Voltage Power Supplies - Power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications.
UNIT-4
Low voltage high current power supplies: Power converters for modern microprocessor and computer loads
UNIT-5
Bi-directional DC-DC (BDC) converters: Electric traction, automotive Electronics and charge/discharge applications, Line Conditioners and Solar Charge Controllers

Course Outcomes: At the end of the course, the student will be able to

- Analyze power electronic application requirements.
- Identify suitable power converter from the available configurations.
- Develop improved power converters for any stringent application requirements.
- Improvise the existing control techniques to suit the application. Design of Bi-directional converters for charge/discharge applications

Text books:
1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters, CRC Press, 2005.

2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition,CRC Press, 2004.
References:
1. William Ribbens: Understanding Automotive Electronics, Newnes, 2003.

2. Current literature

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Microcontrollers (Elective-IV)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Basic micro-processors & micro controllers.

Course Educational Objectives:

- To learn about microcontrollers architecture.
- To learn about DSP architecture and assembly programming for DSP processors.
- To learn about basics of FPGA controllers.

UNIT– 1
PIC Microcontrollers
PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)
UNIT– 2
Introduction to DSP
Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface , System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.
UNIT– 3
I/O & Control Registers
Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.
UNIT– 4
ADC & Event Manager
ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV), Event Manager Interrupts , General Purpose (GP) Timers , Compare UNITs, Capture UNITs And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information
UNIT– 5
Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx C3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming – overview of Spartan 3E and Virtex II pro FPGA boards- case study.

Course Outcomes: At the end of the course, student will be able to

- Design the interfacing circuits for input and output to PIC micro controllers and DSP processors.
- Write ALP for DSP processors.
- Design PWM controller for power electronic circuits using FPGA.

Text Books:

1. Microcontrollers-Theory and Applications - Ajay V Deshmukh, McGraw Hills, 2005.
2. DSP Based Electro Mechanical Motion Control -Hamid.A.Toliyat and Steven G.Campbell, CRC Press New York, 2004.

Reference Books:

1. The 8051 Microcontroller-Kennith J ayala, Thomson publishers,2005.
2. Microprocessor and Microcontrollers by Prof C.R.Sarma.
3. XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998.
4. Wayne Wolf," FPGA based system design ", Prentice hall, 2004

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Electric Drives Simulation Laboratory	Category	L-T-P 0-0-4	Credits 2

Pre-requisite: Power electronics & Drives

Course Educational Objectives:
The student should be able to understand the simulate different electrical machines and drives

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Simulation of DC shunt machine as motor & generator.
2. Simulate the speed control of DC motor using chopper converter.
3. Simulation of induction motor modes using d-q model.
4. Simulate the speed control of induction motor by using V/f control.
5. Simulate the BLDC motor and observe the speed transients.
6. Simulate speed control of induction motor by using vector control.
7. Compare the transient performance of induction motor controlled by v/f control & vector control methods.
8. Simulate PMSM motor by using d-q model.
9. Simulate the multi-level inverter fed induction motor drive.
10. Simulate the re-generative braking of inverter fed induction motor.
11. Study of PWM controlled inverter fed PMSM drive.
12. Evaluation of switching frequency effect on electric drive

Course Objectives:
The student should analyze the performance of different electrical machines and drives

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Electric Drives Laboratory	Category	L-T-P 0-0-4	Credits 2

Course Educational Objectives:
To study the speed control methods of DC & AC drives.

Any 10 of the following experiments are to be conducted.

List of experiments:

1. Study of armature controlled separately excited DC drive with 1-ϕ full converter.
2. Study of chopper controlled separately excited DC drive.
3. Study of armature controlled separately excited DC drive with 3-ϕ full converter
4. Study of dynamic braking of DC drives.
5. Study of regenerative braking of DC drive.
6. Study of performance characteristics of a 3-ϕ induction motor using V/f control.
7. Vector control based speed control of induction motor.
8. Study of direct torque control of induction motor.
9. Speed control of PMSM drive with 3-ϕ inverter.
10. Speed control of BLDC drive with 3-ϕ inverter.
11. Speed control of switched reluctance motor drive.

Course Outcome: The student should Understand the performance of DC & AC drives.

II-Semester	Mini Project with Seminar	Category	L-T-P 0-0-4	Credits 2

Note:

It is recommended that a Supervisor/advisor should be allotted to each student at the end of the semester-I or allot at the start of the semester-II

Syllabus content:

A Student has to select one paper published in any of the IEEE Transactions and simulate the same. The student has to present the progress of the work at the middle of the semester. At the end of the semester, the student has to present the results by explaining the idea of the topic, methodology, finding of the simulations. A Student should also submit a report of the entire work carried out under this course. The end semester presentation must be video recorded and preserved.

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KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Audit Course-II	Category	L-T-P 2-0-0	Credits 3

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

III-Semester	Digital Signal Processor Controlled Drives (Program Elective - V)	Category	L-T-P 3-0-0	Credits 3

Pre-requisite: Applications of Digital Signal Processors, Power Electronic control of Electrical Drives.

Course Educational Objectives:

- To study DSP controllers.
- To learn coding in DSP's to control the electric drive speed.
- To learn speed control methods for induction motor, PMSM, BLDC motors.

UNIT-1
Overview of TMS320LF2407 DSP controller: Review ofInstruction Set, Interrupts, normalization and number formatting.
UNIT-2
Clarke's and Park's transformations: Review ofClarke's and Park's transformations, Implementation of Clarke's and Park's transformation using TMS320LF2407 DSP
UNIT-3
Implementation of PWM Techniques for 3-Ph VSI: Implementation of Sine-triangle and SVPWM withTMS320LF2407 DSP using the concept of imaginary switching time
UNIT-4
Control of BLDC Motor: Principle of operation with Drive control system, implementation of control system using TMS320LF2407 DSP
UNIT-5
Control of PMSM: Principle of operation with drive control system, implementation of vector control using TMS320 LF2407DSP
UNIT-6
Control of Induction Motor: Implementation offield oriented control for the speed control of Induction Motor using TMS320LF2407 DSP.

Course Outcomes: At the end of the course, student will be able to

- Interface the DSP platform with sensors such as hall-effect voltage sensors,
- Use hall-effect current sensors, shaft encoder for data acquisition for motor drive applications
- Scale and normalize the data to suit the requirements of the drive system
- Exploit the architectural features of the DSP platform to design and implement
- Use algorithms for the realization of controllers, Pulse Width Modulators and observers

Text Books:

1. Hamid A. Toliyat: DSP Based Electromechanical Motion Control, 1st Edition, CRC Press, 2004

2. Ned Mohan, T.M. Undeland and William P. Robbins: Power Electronics: Converters, Applications, 3rd Edition, John Wiley & Sons, 2009

Reference:

1. Application Notes from the website of Texas Instruments .

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

III-Semester	Smart Grid Technologies (Program Elective–V)	Category	L-T-P 3 -0-0	Credits 3

Pre-requisite: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for

UNIT – 1

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT – 2

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT – 3

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT – 4

Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT – 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

monitoring and protection.

Course Outcomes:

At the end of this course, the student will be able to:

- Understand smart grids and analyze the smart grid policies and developments in smart grids.
- Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- Understand smart substations, feeder automation, GIS etc.
- Analyze micro grids and distributed generation systems.
- Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II-Semester	Modeling and Simulation of Power Electronic Systems (Program Elective–V)	Category	L-T-P 3 -0-0	Credits 3

Pre-requisites: Analysis of Power Electronic Converters

Course Educational Objectives:

- To learn the simulation techniques in Power Electronic Converters.
- To learn the modeling the Power Electronic Converters.
- To simulate control methods for Power Electronic Converters.

UNIT-1

Introduction: Challenges in computer simulation - Simulation process - mechanics of simulation, Solution techniques for time domain analysis - Equation solvers, circuit-oriented simulators.

UNIT-2

Simulation of power electronic converters: MNA and ST Approaches- Nodal Analysis, Modified Nodal Analysis, The Spare Tableau Approach, Nonlinear Circuits - The Newton-Raphson Method, Computation Time, Convergence Issues, Nonlinear Circuit Equations, Introduction to Transient Simulation - Introduction, Discretization of Time, Transient Analysis, Accuracy and Stability, Explicit and Implicit Schemes, Methods for Transient Simulation - FE, BE and TRZ, Transient Analysis in Circuit Simulation, Equivalent Circuit Approach: RC Circuit, Buck Converter; Some Practical Aspects: Undamped Oscillations, Ringing, Global Error in Switching Circuits, Round-off Error, Assessment of Accuracy, Singular Matrix Problem, Trapezoidal integration, M & N method for simulating power electronic converters (with buck converter as a representative example).

UNIT-3

Switching function: Introduction, Application of the switching function technique, Properties of the switching function, Voltage-Current relations in switched circuits - Single Switch, Parallel Switch, Pulse Width Modulation- Unipolar, PWM Signal of a composite function, bipolar square wave modulation, Mathematical Modeling of Buck Converter, Modeling using switching function-buck converter, Rectifier, 3-phase VSI inverter, matrix converter, m-phase rectifier. PWM rectifier topologies, Modeling of power electronic converters - PWM rectifier in different frames- abc, alpha-beta and d-q.

UNIT-4

Modeling, simulation of switching converters with state space averaging, hybrid model: State space approach, averaging method, State Space Averaging Technique – Modeling AND linearization of converter transfer functions- Hybrid Modeling for DC-DC converter.

Course Outcomes: After the completion of the course, student will be able to

- Understand the back ground activities i.e. numerical solution used in the simulation software.
- Can judge or properly choose the required numerical solver to be used for analysis.
- Can understand and debug the convergence problems occurring during simulation.

Text book:

1. M. B. Patil, V. Ramnarayanan, V. T. Ranganathan**:** *Simulation of Power Electronic Converters***,** 1st ed., Narosa Publishers, 2010

Reference book:

1. Ned Mohan, Undeland and Robbins**, "**Power Electronics: Converters, Design and control**"-** 2nd ed., John Wiley.

II-Semester	Industrial Safety (Open Elective)	Category	L-T-P 3 -0-0	Credits 3

Pre-requisite: Engineering Fundamentals

Course Educational Objectives:

- To learn safety aspects of any industrial area
- To learn fundamentals and types of maintenance engineering
- To learn causes and effects of wear and Corrosion and their prevention
- To learn identification of faults and their repair
- To learn preventive maintenance- periodic an preventive-maintenance of industrial systems

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reductionmethods, lubricants-types and applications, Lubrication methods, general sketch, working andapplications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravitylubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need andapplications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Course Outcomes: At the end of the course, the student should be able to

- Understand the general industrial requirements like lighting, cleanliness prevention from hazards and accidents.
- Analyze maintenance requirements of the industry and cost associated.
- Analyze wear and corrosion aspects of the industry and their prevention.
- Identify the faults prone areas and their repair and periodic maintenance.

Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

III-Semester	Energy Audit Conservation & Management (Open Elective)	Category	L-T-P 3 -0-0	Credits 3

Pre-requisite: Concepts of utilization of electrical energy, electrical machines and electrical measurements.

Course educational objectives:

- To learn principle of energy audit as well as management for industries and utilities and buildings.
- To study the energy efficient motors and lighting.
- To learn power factor improvement methods and operation of different energy instruments.
- To compute depreciation methods of equipment for energy saving.

UNIT– 1
Basic Principles of Energy Audit
Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.
UNIT– 2
Energy Management
Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manager, qualities and functions, language, Questionnaire – check list for top management
UNIT– 3
Energy Efficient Motors and Lighting
Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems, RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice, lighting control, lighting energy audit
UNIT– 4
Power Factor Improvement and energy instruments
Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f, p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers,application of PLC's
UNIT– 5
Economic Aspects and their computation
Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

Course Outcomes: At the end of the course, student will be able to

- Understand the principle of energy audit and their economic aspects.
- Recommend energy efficient motors and design good lighting system.
- Understand advantages to improve the power factor.
- Evaluate the depreciation of equipment.

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth, Heinemann publications, 1982.
2. Energy management hand book by W.CTurner, John Wiley and sons, 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

III-Semester	Composite Materials (Open Elective)	Category	L-T-P 3 -0-0	Credits 3

Pre-requisite: Engineering Physics

Course Educational Objectives:

- To learn characteristics of composite materials and know effects of reinforcement
- To learn application of different fibers, understand rules of mixtures
- To learn manufacturing of ceramic matrix, carbon matrix and applications
- To learn preparation of moulding compounds ,properties and applications
- To learn strength and failure criteria

UNIT–1: INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites.Functional requirements of reinforcement and matrix.Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – 2: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – 3: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostaticpressing, Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–4: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – 5: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Course Outcomes: At the end of the course, students should be able to

- Understand characteristics and advantages of composite materials
- Acquire knowledge of reinforcement, glass fiber, etc.
- Identify the usage of metal matrix composites
- Understand manufacturing of polymer matrix composites
- Understand manufacturing of polymer matrix composites
- Identify different types of failures.

Text Books:
1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

Reference Books:
1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

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KAKINADA – 533 003, Andhra Pradesh, India

III SEMESTER	DISSERTATION PHASE-I	CATEGORY	L-T-P 0-0-20	CREDIT 10

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

IV SEMESTER	DISSERTATION PHASE-II	CATEGORY	L-T-P 0-0-32	CREDIT 16

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:
Students will be able to:
Understand that how to improve your writing skills and level of readability
Learn about what to write in each section
Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Syllabus

Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: DISASTER MANAGEMENT

Course Objectives: -Students will be able to:
learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Units	CONTENTS	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man- made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood

Being a logical language will help to develop logic in

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
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AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

5. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
6. Learning of Sanskrit to improve brain functioning
7. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
8. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

4. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
5. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
6. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: VALUE EDUCATION

Course Objectives

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course outcomes

Students will be able to 1.Knowledge of self-development
2.Learn the importance of Human values 3.Developing the overall personality

AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
1	• **History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)	4
2	• **Philosophy of the Indian Constitution:** Preamble Salient Features	4
3	**Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	4

4	**Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions • Executive President Governor Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	4
5	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CE of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	O 4
6	**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

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AUDIT 1 and 2: PEDAGOGY STUDIES

Course Objectives:
Students will be able to:

4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.	4
2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change. • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	• Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	**Research gaps and future directions** Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.	2

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

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AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Syllabus

Unit	Content	Hours
1	• Definitions of Eight parts of yog. (Ashtanga)	8
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam 1. Various yog poses and their benefits for mind & body 2. Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

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AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78 (do's)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8

Suggested reading

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

Study of Neetishatakam will help in developing versatile personality of students

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE-R19

COURSE STRUCTURE AND SYLLABUS

For

B. TECH ELECTRICAL AND ELECTRONICS ENGINEERING

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE-R19

I Year – I SEMESTER

Sl. No	Course Code	Subjects	L	T	P	Credits
1	HS1101	English	3	0	0	3
2	BS1101	Mathematics - I	3	0	0	3
3	BS1106	Applied Chemistry	3	0	0	3
4	ES1101	Programming for Problem Solving Using C	3	0	0	3
5	ES1103	Engineering Drawing	1	0	3	2.5
6	HS1102	English Lab	0	0	3	1.5
7	BS1107	Applied Chemistry Lab	0	0	3	1.5
8	ES1102	Programming for Problem Solving Using C Lab	0	0	3	1.5
9	MC1101	Environmental Science	3	0	0	0
Total Credits			**16**	**0**	**12**	**19**

I Year – II SEMESTER

Sl. No	Course Code	Subjects	L	T	P	Credits
1	BS1202	Mathematics – II	3	0	0	3
2	BS1203	Mathematics – III	3	0	0	3
3	BS1204	Applied Physics	3	0	0	3
4	ES1212	Fundamentals of Computers	3	0	0	3
5	ES1217	Electrical Circuit Analysis - I	3	0	0	3
6	ES1218	Electrical Engineering Workshop	0	0	3	1.5
7	BS1205	Applied Physics Lab	0	0	3	1.5
8	HS1203	Communication Skills Lab	0	1	2	2
9	PR1201	Engineering Exploration Project	0	0	2	1
Total Credits			**15**	**1**	**10**	**21**

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE-R19

II Year – I SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Electrical Circuit Analysis - II	EE	3	--	--	3
2		Electrical Machines-I	EE	3	--	--	3
3		Electronic Devices and Circuits	ES	3	--	--	3
4		Electro Magnetic Fields	EE	3	--	--	3
5		Thermal and Hydro Prime movers	ES	3	--	--	3
6		Managerial Economics & Financial Analysis	BS	3	--	--	3
7		Thermal and Hydro Laboratory	ES	--	--	3	1.5
8		Electrical Circuits Laboratory	EE	--	--	3	1.5
9		Essence of Indian Traditional Knowledge	MC	3	--	--	0
Total Credits				**24**	**0**	**6**	**21**

II Year – II SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Electrical Measurements & Instrumentation	EE	3	--	--	3
2		Electrical Machines-II	EE	3	--	--	3
3		Digital Electronics	ES	3	--	--	3
4		Control Systems	EE	3	--	--	3
5		Power Systems-I	EE	3	--	--	3
6		Signals and Systems	EE	3	--	--	3
7		Electrical Machines -I Laboratory	EE	--	--	3	1.5
8		Electronic Devices & Circuits Laboratory	EE	--	--	3	1.5
9		Professional Ethics and Human Values	MC	3	0	0	0
Total Credits				**21**	**0**	**6**	**21**

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COURSE STRUCTURE-R19

III Year – I SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Power Systems-II	EE	3	--	--	3
2		Power Electronics	EE	3	--	--	3
3		Linear IC Applications	ES	3	--	--	3
4		Digital Signal Processing	EE	3	--	--	3
5		Microprocessors and Microcontrollers	EE	3	--	--	3
6		Electrical Machines-II Laboratory	EE	--	--	3	1.5
7		Control Systems Laboratory	EE	--	--	2	1
8		Electrical Measurements & Instrumentation Laboratory	EE	--	--	3	1.5
9		Socially Relevant Projects	MC	--	--	1	1
Total Credits				**15**	**0**	**9**	**20**

III Year – II SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Electric Drives	EE	3	--	--	3
2		Power System Analysis	EE	3	--	--	3
3		Data Structures	ES	3	--	--	3
4		Digital Control Systems	EE	3	--	--	3
5		**Elective - I**	EL	3	--	--	3
6		**Open Elective - I**	OE	3	--	--	3
7		Power Electronics Laboratory	EE	--	--	3	1.5
8		Microprocessors & Microcontrollers Laboratory	EE	--	--	3	1.5
9		Employability Skills	MC	3	--	--	0
Total Credits				**18**		**6**	**21**

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COURSE STRUCTURE-R19

IV Year – I SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Switchgear & Protection	EE	3	--	--	3
2		OOPs through JAVA	ES	3	--	--	3
3		Renewable Energy Systems	EE	3	--	--	3
4		**Elective – II**	EL	3	--	--	3
5		**Elective - III**	EL	3	--	--	3
6		Linear & Digital IC Applications Laboratory	ES	--	--	2	1
7		Power Systems& Simulation Laboratory	EE	--	--	2	1
		Industrial Training /Skill Development Programmes / Research Project	Project	--	--	2	1
8		Project-I	Project			4	2
Total Credits				**15**	**0**	**10**	**20**

IV Year – II SEMESTER

S. No	Course Code	Subjects	Category	L	T	P	Credits
1		Power System Operation & Control	EE	3	--	--	3
2		**Open Elective - II**	OE	3	--	--	3
3		**Elective - IV**	EL	3	--	--	3
4		Project-II	Project	--	--	16	8
Total Credits				**09**		**16**	**17**

BS – Basic Sciences **EE – Electrical Engineering**
HS – Humanity Sciences **OE – Open Elective** **Proj- Project**
ES – Engineering Sciences **EL – Elective** **MC–Mandatory Course**

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COURSE STRUCTURE-R19

Elective – I:

1. Digital IC Applications
2. Communication Systems
3. Computer Networks
4. Internet of Things applications to Electrical Engineering
5. VLSI Design
6. Cloud Computing

Elective – II:

1. Utilization of Electrical Energy
2. Data Base Management System
3. Advanced Control Systems
4. Electrical Machine Design
5. Hybrid Electric Vehicles
6. Swayam Course

Elective – III:

1. Operating Systems
2. Neural Networks &Fuzzy Logic
3. High Voltage Engineering
4. Energy Auditing and Demand Side Management
5. Data Analytics with Python
6. Swayam Course

Elective – IV:

1. Electrical Distribution Systems
2. HVAC & DC Transmission
3. Flexible Alternating Current Transmission Systems
4. Power Quality
5. Smart Grid
6. Special Electrical Machines

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COURSE STRUCTURE-R19

Open Electives offered by EEE Department for Other Branches(Except for EEE Branch)

Open Elective-I:

1. Renewable Energy Sources
2. Essentials of Analog and Digital Electronics
3. Electrical Estimation and Costing
4. Power Electronic Devices & Circuits
5. Fundamentals of Electrical Machines

Open Elective-II:

1. Measurements & Instrumentation
2. Fundamentals of Utilization of Electrical Energy
3. Concepts of Power System Engineering
4. Basics of Control Systems
5. Energy Audit

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		3	0	0	3
ENGLISH (HS1101)					

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE-R19

Unit 1:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications
Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)
Listening: Listening to short audio texts and identifying the topic. Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions both in speaking and writing.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.

Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.
Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit 2:

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.

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Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

Grammar: Use of articles and zero article; prepositions.

Pronunciation: Past tense markers, word stress-di-syllabic words

Unit 3:

Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Pronunciation: word stress-poly-syllabic words

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Unit 4:

Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.** (Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.

Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.

Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Pronunciation: Contrastive Stress

Unit 5:

Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

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Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.

Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.

Reading for Writing: Writing academic proposals- writing research articles: format and style.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Pronunciation: Stress in compound words

Prescribed text books for theory:

1. "**Infotech English**", Maruthi Publications. (Detailed)
2. "**The Individual Society",** Pearson Publications. (Non-detailed)

Reference books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT;
2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-I (BS1101) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- This course will illuminate the students in the concepts of calculus.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- utilize mean value theorems to real life problems (L3)
- solve the differential equations related to various engineering fields (L3)
- familiarize with functions of several variables which is useful in optimization (L3)
- Apply double integration techniques in evaluating areas bounded by region (L3)
- students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)

UNIT I: Sequences, Series and Mean value theorems: (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

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UNIT II: Differential equations of first order and first degree: (10 hrs)

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form.
Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

UNIT III: Linear differential equations of higher order: (10 hrs)

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters.
Applications: LCR circuit, Simple Harmonic motion.

UNIT IV: Partial differentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT V: Multiple integrals: (8 hrs)

Double and Triple integrals – Change of order of integration – Change of variables.
Applications: Finding Areas and Volumes.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition, Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press, 2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		3	0	0	3
APPLIED CHEMISTRY (BS1106)					

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Learning Objectives:

- ***Importance*** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- ***Outline*** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.
- ***Express*** the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.
- ***Explain*** the crystal structures, and the preparation of semiconductors. Magnetic properties are also studied.
- ***Recall*** the increase in demand for power and hence alternative sources of power are studied due to depleting sources of fossil fuels. Advanced instrumental techniques are introduced.

UNIT I POLYMER TECHNOLOGY

Polymerisation:- Introduction-methods of polymerization (emulsion and suspension)-physical and mechanical properties.

Plastics: Compounding-fabrication (compression, injection, blown film, extrusion) - preparation, properties and applications of PVC, polycarbonates and Bakelite-mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers:- Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics-conducting polymers-biodegradable polymers-biopolymers-biomedical polymers.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Outline*** the properties of polymers and various additives added and different methods of forming plastic materials.
- ***Explain*** the preparation, properties and applications of some plastic materials.
- ***Interpret*** the mechanism of conduction in conducting polymers .
- ***Discuss*** natural and synthetic rubbers and their applications.

UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

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Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells–Fuel cells: H_2-O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion:-Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Explain*** the theory of construction of battery and fuel cells.
- ***Categorize*** the reasons for corrosion and study some methods of corrosion control.

UNIT III: MATERIAL CHEMISTRY

Part I ***: Non-elemental semiconducting materials:-*** Stoichiometric, controlled valency & chalcogen photo/semiconductors-preparation of semiconductors (distillation, zone refining, Czochralski crystal pulling, epitaxy, diffusion, ion implantation) - Semiconductor devices (p-n junction diode as rectifier, junction transistor).

Insulators & magnetic materials: electrical insulators-ferro and ferri magnetism-Hall effect and its applications.

Part II:

Nano materials:- Introduction-sol-gel method- characterization by BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes: Types, preparation and applications

Liquid crystals:- Introduction-types-applications.

Super conductors:-Type –I, Type II-characteristics and applications

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Understand*** the importance of materials like nanomaterials and fullerenes and their uses.
- ***Understand*** liquid crystals and superconductors.
- ***Understand*** the preparation of semiconductors.

UNIT IV: ADVANCED CONCEPTS/TOPICS IN CHEMISTRY

Computational chemistry: Introduction, Ab Initio studies

Molecular switches**:** characteristics of molecular motors and machines, Rotaxanes and Catenanes as artificial molecular machines, prototypes – linear motions in rotaxanes, an acid-base controlled molecular shuttle, a molecular elevator, an autonomous light-powered molecular motor

Learning Outcomes: ***At the end of this unit, the students will be able to***

- ***Obtain*** the knowledge of computational chemistry
- ***Understand*** importance molecular machines

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UNIT V: SPECTROSCOPIC TECHNIQUES & NON CONVENTIONAL ENERGY SOURCES

Part A: **SPECTROSCOPIC TECHNIQUES**

Electromagnetic spectrum-UV (laws of absorption, instrumentation, theory of electronic spectroscopy, Frank-condon principle, chromophores and auxochromes, intensity shifts, applications), FT-IR (instrumentation and IR of some organic compounds, applications)-magnetic resonance imaging and CT scan (procedure & applications).

Part B*:* NON CONVENTIONAL ENERGY SOURCES

Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, hydropower, geothermal power, tidal and wave power, ocean thermal energy conversion.

Learning Outcomes: ***At the end of this unit, the students will be able to***

- understand the principles of different analytical instruments.
- explain the different applications of analytical instruments.
- design sources of energy by different natural sources.

Standard Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co.

Reference Books:

1. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C (ES1101)					

COURSE OBJECTIVES:

The objectives of Programming for Problem Solving Using C are

1) To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
2) To gain knowledge of the operators, selection, control statements and repetition in C
3) To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
4) To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
5) To assimilate about File I/O and significance of functions

UNIT I

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

UNIT II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

UNIT IV

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Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value
Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application
Processor Commands: Processor Commands

UNIT V
Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion
Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions
Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

TEXT BOOKS:

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e, Pearson

REFERENCES:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, Amit Kamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

COURSE OUTCOMES:

Upon the completion of the course the student will learn

1) To write algorithms and to draw flowcharts for solving problems
2) To convert flowcharts/algorithms to C Programs, compile and debug programs
3) To use different operators, data types and write programs that use two-way/ multi-way selection
4) To select the best loop construct for a given problem
5) To design and implement programs to analyze the different pointer applications
6) To decompose a problem into functions and to develop modular reusable code
7) To apply File I/O operations

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I Year - I Semester		L	T	P	C
		1	0	3	2.5
ENGINEERING DRAWING (ES1103)					

Course Objective: Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I

Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.

Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.

Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.

Scales: Plain scales, diagonal scales and vernier scales

Unit II

Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.

Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.

Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III

Objective: The objective is to make the students draw the projections of the plane inclined to both the planes.

Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV

Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit V

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COURSE STRUCTURE-R19

Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.
Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD

Note: In the End Examination there will be no question from CAD.

TEXT BOOKS:

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

Course Outcome: The student will learn how to visualize 2D & 3D objects.

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH LAB (HS1102)					

UNIT I:
Vowels, Consonants, Pronunciation, Phonetic Transcription

UNIT II:

Past tense markers, word stress-di-syllabic words, Poly-Syllabic words

UNIT III:

Rhythm & Intonation

UNIT IV:

Contrastive Stress (Homographs)

UNIT V:

Word Stress: Weak and Strong forms
Stress in compound words

References books:

1. Infotech English, Maruthi Publications (with Compact Disc).
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
5. English Pronunciation in use- Mark Hewings, Cambridge University Press.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
APPLIED CHEMISTRY LAB (BS1107)					

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions,
volumetric titrations, quantitative analysis

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of iron (III) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ present in an egg shell.
13. Estimation of Vitamin C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LAB (ES1202)					

Course Objectives:

1) Apply the principles of C language in problem solving.
2) To design flowcharts, algorithms and knowing how to debug programs.
3) To design & develop of C programs using arrays, strings pointers & functions.
4) To review the file operations, preprocessor commands.

Exercise 1:

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

Exercise 2:

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3:

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

Exercise 4:

1. Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum. 1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5:

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

Exercise 6:

1. Write a program in C for multiplication of two square Matrices.
2. Write a program in C to find transpose of a given matrix.

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Exercise 7:

1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.

Exercise 8:

1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

Exercise 9:

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10:

1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers using pointers.

Exercise 11:

1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12:

1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13:

1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14:

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand the difference between the above two programs
2. Write a program in C to convert decimal number to binary number using the function.

Exercise 15:

1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

Exercise 16:

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

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Course Outcomes:

By the end of the Lab, the student

1) Gains Knowledge on various concepts of a C language.
2) Able to draw flowcharts and write algorithms.
3) Able design and development of C problem solving skills.
4) Able to design and develop modular programming skills.
5) Able to trace and debug a program

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COURSE STRUCTURE-R19

I Year - I Semester		L	T	P	C
		3	0	0	0
ENVIRONMENTAL SCIENCE (MC1101)					

Learning Objectives:
The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

UNIT-I:
Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.
Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II:
Natural Resources: Natural resources and associated problems.
Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.
Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.
Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.
Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.
Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

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UNIT-III:

Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT – IV Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Text Books:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

Reference:

1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2014

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - II (BS1202) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate approximating the roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations (L3)

Unit I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous equations linear equations – Gauss Elimination for solving system of equations – Eigen values and Eigen vectors and their properties.

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Unit-II: Cayley-Hamilton theorem and Quadratic forms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Finding inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation.

Singular values of a matrix, singular value decomposition (Ref. Book – 1).

UNIT III: Iterative methods: (8 hrs)

Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations) – Jacobi and Gauss-Seidel methods for solving system of equations.

UNIT IV: Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

UNIT V: Numerical integration and solution of ordinary differential equations: (10 hrs)

Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method (second and fourth order).

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43^{rd} Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **David Poole,** Linear Algebra- A modern introduction, 4^{th} Edition, Cengage.
2. **Steven C. Chapra,** Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.

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3. **M. K. Jain, S. R. K. Iyengar and R. K. Jain,** Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - III (BS1203) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Course Outcomes: At the end of the course, the student will be able to

- interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- estimate the work done against a field, circulation and flux using vector calculus (L5)
- apply the Laplace transform for solving differential equations (L3)
- find or compute the Fourier series of periodic signals (L3)
- know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- identify solution methods for partial differential equations that model physical processes (L3)

Unit – I: Vector calculus: **(10 hrs)**

Vector Differentiation: Gradient – Directional derivative – Divergence – Curl – Scalar Potential.

Vector Integration: Line integral – Work done – Area – Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof).

Unit –II: Laplace Transforms: **(10 hrs)**

Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (with out proof).

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Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

Unit –III: Fourier series and Fourier Transforms: (10 hrs)

Fourier Series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties – inverse transforms – Finite Fourier transforms.

Unit –IV: PDE of first order: **(8 hrs)**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT V: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients – RHS term of the type $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

Applications of PDE: Method of separation of Variables – Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Dean. G. Duffy,** Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.

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3. **Peter O' Neil,** Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		3	0	0	3
APPLIED PHYSICS (BS1204)					

Course Objectives:

Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by Jawaharlal Nehru Technological University Kakinada that serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart Knowledge of Physical Optics phenomena like Interference and Diffraction required to design instruments with higher resolution.
- Understand the physics of Semiconductors and their working mechanism for their utility in sensors.
- To impart the knowledge of materials with characteristic utility in appliances.

UNIT-I **(10hrs)**

WAVE OPTICS: Principle of Superposition - Interference of light - Conditions for sustained Interference - Interference in thin films (reflected geometry) - Newton's Rings (reflected geometry).

Diffraction - Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit, N -slits and circular aperture (qualitative) – Intensity distribution curves - Diffraction Grating – Grating spectrum – missing order – resolving power – Rayleigh's criterion – Resolving powers of Microscope, Telescope and grating (qualitative).

Unit Outcomes:

The students will be able to

- **explain** the need of coherent sources and the conditions for sustained interference.
- **analyze** the differences between interference and diffraction with applications.
- **illustrate** the resolving power of various optical instruments.

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UNIT-II **(9hrs)**

QUANTUM MECHANICS: Introduction – Matter waves – de Broglie's hypothesis – Davisson-Germer experiment – G. P. Thomson experiment – Heisenberg's Uncertainity Principle –interpretation of wave function – Schröedinger Time Independent and Time Dependent wave equations – Particle in a potential box.

Unit Outcomes:

The students will be able to

- **explain** the fundamental concepts of quantum mechanics.
- **analyze** the physical significance of wave function.
- **apply** Schrödinger's wave equation for energy values of a free particle .

UNIT-III **(10hrs)**

FREE ELECTRON THEORY & BAND THEORY OF SOLIDS : Introduction – Classical free electron theory (merits and demerits only) - Quantum Free electron theory – electrical conductivity based on quantum free electron theory – Fermi Dirac distribution function – Temperature dependence of Fermi-Dirac distribution function - expression for Fermi energy - Density of states .

Bloch's theorem (qualitative) – Kronig-Penney model(qualitative) – energy bands in crystalline solids – E Vs K diagram – classification of crystalline solids – effective mass of electron – m^* Vs K diagram - concept of hole.

Unit Outcomes:

The students will be able to

- **explain** the various electron theories.
- **calculate** the Fermi energy.
- **analyze** the physical significance of wave function .
- **interpret** the effects of temperature on Fermi Dirac distribution function.
- **summarise** various types of solids based on band theory.

UNIT-IV **(9hrs)**

SEMICONDUCTOR PHYSICS: Introduction – Intrinsic semi conductors - density of charge carriers - Electrical conductivity – Fermi level – extrinsic semiconductors - p-type & n-type - Density of charge carriers - Dependence of Fermi energy on carrier concentration and

temperature – Hall effect- Hall coefficient - Applications of Hall effect - Drift and Diffusion currents – Einstein's equation.

Learning Outcomes:
The students will be able to

- **classify** the energy bands of semiconductors.
- **outline** the properties of n-type and p-type semiconductors.
- **identify** the type of semiconductor using Hall effect.

UNIT-V **(10 hrs)**

MAGNETISM & DIELECTRICS: Introduction – Magnetic dipole moment – Magnetization – Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr magneton – Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – applications of Ferromagnetic material.

Introduction - Dielectic polarization – Dielectric Polarizability, Susceptibility and Dielectric constant-types of polarizations: Electronic and Ionic (Quantitative), Orientational polarizations (qualitative) – Lorentz Internal field – Claussius-Mossoti equation - Frequency dependence of polarization – Applications of dielectrics.

Unit Outcomes:
The students will be able to

- **explain** the concept of polarization in dielectric materials.
- **summarize** various types of polarization of dielectrics .
- **interpret** Lorentz field and Claussius- Mosotti relation in dielectrics.
- **classify** the magnetic materials based on susceptibility and their temperature dependence.
- **explain** the applications of dielectric and magnetic materials .
- **Apply** the concept of magnetism to magnetic devices.

TEXT BOOKS:

1. "A Text book of Engineering Physics" by M.N. Avadhanulu, P.G.Kshirsagar - S.Chand Publications, 2017.
2. "Engineering Physics" by D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).
3. "Engineering Physics" by R.K Gaur. and S.L Gupta., - Dhanpat Rai publishers, 2012.

REFERENCE BOOKS:

1. "Engineering Physics" by M. R. Srinivasan, New Age international publishers (2009).

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2. "Optics" by Ajoy Ghatak, 6th Edition McGraw Hill Education, 2017.
3. "Solid State Physics" by A. J. Dekker, Mc Millan Publishers (2011).

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF COMPUTER SCIENCE (ES1212)					

COURSE OBJECTIVES:

This course is designed to:

1. Explain the concepts of computers and classify based on type and generation.
2. Demonstrate the techniques of writing algorithms pseudo codes & schematic flow of logic in software development process.
3. Teach about the purpose of networks and types of networks and media to connect the computers
4. Teach about Operating Systems and its concepts.
5. Illustrate about database architecture and its components
6. Illustrate about distributed computing, peer to peer, grid, cloud on demand and utility computing.

UNIT I:

A Simple Computer System: Central processing unit, the further need of secondary storage, Types of memory, Hardware, Software and people.

Peripheral Devices: Input, Output and storage, Data Preparation, Factors affecting input, Input devices, Output devices, Secondary devices, Communication between the CPU and Input/ Output devices. (Text Book 1)

UNIT II:

Problem Solving and Programming: Algorithm development, Flowcharts, Looping, some programming features, Pseudo code, the one-zero game, some structured programming concepts, documents.

Programming Languages: Machine Language and assembly language, high -level and low level languages, Assemblers, Compilers, and Interpreters (Text Book 1)

UNIT III:

Computer Networks : Introduction to computer Networks, Network topologies-Bus topology, star topology, Ring topology, Mesh topology, Hybrid topology, Types of Networks: Local area Network, Wide Area Networks, Metropolitan Networks, Campus/ Corporate Area Network, Personal Area Network, Network Devices- Hub, Repeater, Switch, Bridge, Router, Gateway, Network interface Card, Open System Inter connection Model (Text Book 2)

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Operating systems: Introduction, Evolution of operating systems, Process Management-Process control block, Process operations, Process scheduling, Command Interpreter, Popular operating systems- Microsoft DOS, Microsoft Windows, UNIX and Linux. (Text Book 2)

UNIT IV:

Database Systems: File-Oriented Approach, Database-oriented Approach-Components of Database system, Advantages & Disadvantages of Database approach, Applications of Database systems, Database views, Three-schema architecture, Database models-Hierarchical model, Network Model, relational Model, Object-oriented Data Model, Components of database management systems, Retrieving Data through Queries (Text Book 2)

Computer Systems and Development: Investigation, Analysis, Design, system processing and general program design, Presentation to management and users, Implementation, Documents. (Text Book 1)

UNIT V:

Emerging Computer Technologies: Distributed Networking, Peer-to-peer Computing, Categorization of Peer-to-peer system Applications of Peer-to-peer networks, Grid Computing-components of Grid computing, Applications of Grid computing,, Cloud Computing-characteristics of cloud computing systems, cloud computing services, cloud computing architecture, cloud computing applications, Cloud computing concerns

Wireless Networks: Wireless network operations, Types of wireless networks, security in wireless Networks, Limitations of wireless Networks, Bluetooth – Bluetooth Piconets, Avoiding Interference in Bluetooth Devices, Bluetooth Security, Differences between Bluetooth and Wireless Networks. (Text Book 2)

TEXT BOOKS:

1. An Introduction to Computer studies –Noel Kalicharan-Cambridge
2. Fundamentals of Computers –Reema Thareja-Oxford higher education

REFERENCES:

1. Introduction to Information Technology – ITL education Solution Limited, Pearson
2. Computer Science and overview-J. Glenn Brookshear, Dennis Brylow-Pearson

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COURSE OUTCOMES:

On completion of the course the student will be able to

1. Explain the concept of input and output devices of Computers and how it works and recognize the basic terminology used in computer programming.
2. Recognize the Computer networks, types of networks and topologies.
3. Summarize the concepts of Operating Systems and Databases.
4. Recite the Advanced Computer Technologies like Distributed Computing & Wireless Networks.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		3	0	0	3
ELECTRICAL CIRCUIT ANALYSIS - I (ES1217)					

Preamble:
This course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the basic analysis of circuits which includes single phase circuits, magnetic circuits, network theorems, transient analysis and network topology.

Learning Objectives:

- To study the concepts of passive elements, types of sources and various network reduction techniques.
- To understand the applications of network topology to electrical circuits.
- To study the concept of magnetic coupled circuit.
- To understand the behavior of RLC networks for sinusoidal excitations.
- To study the performance of R-L, R-C and R-L-C circuits with variation of one of the parameters and to understand the concept of resonance.
- To understand the applications of network theorems for analysis of electrical networks.

UNIT-I

Introduction to Electrical Circuits
Basic Concepts of passive elements of R, L, C and their V-I relations, Sources (dependent and independent),Kirchoff's laws, Network reduction techniques(series, parallel, series - parallel, star-to-delta and delta-to-star transformation), source transformation technique, nodal analysis and mesh analysis to DC networks with dependent and independent voltage and current sources.

UNIT-II

Magnetic Circuits
Basic definition of MMF, flux and reluctance, analogy between electrical and magnetic circuits, Faraday's laws of electromagnetic induction – concept of self and mutual inductance, Dot convention – coefficient of coupling and composite magnetic circuit, analysis of series and parallel magnetic circuits.

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UNIT-III

Single Phase A.C Systems
Periodic waveforms (determination of rms, average value and form factor), concept of phase angle and phase difference – waveforms and phasor diagrams for lagging, leading networks, complex and polar forms of representations.

Steady state analysis of R, L and C circuits,power factor and its significance, real,reactive and apparent power, waveform of instantaneous power and complex power

UNIT-IV

Analysis of AC Networks
Extension of node and mesh analysis to AC networks, series and parallel resonance, selectively band width and Quality factor, introduction to locus diagram.

UNIT-V

Network theorems (DC & AC Excitations)
Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

Learning Outcomes:
The Student should be able to solve

- Various electrical networks in presence of active and passive elements.
- Electrical networks with network topology concepts.
- Any magnetic circuit with various dot conventions.
- Any R, L, C network with sinusoidal excitation.
- Any R, L, network with variation of any one of the parameters i.e R, L, C and f.
- Electrical networks by using principles of network theorems.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6 th edition
2. Network Analysis: Van Valkenburg; Prentice-Hall of India Private Ltd

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, Mc Graw Hill Education (India)
2. Linear Circuit Analysis by De Carlo, Lin, Oxford publications

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3. Electric Circuits – (Schaum's outlines) by Mahmood Nahvi & Joseph Edminister, Adapted by Kuma Rao, 5th Edition – Mc Graw Hill.
4. Electric Circuits by David A. Bell, Oxford publications
5. Introductory Circuit Analysis by Robert L Boylestad, Pearson Publications
6. Circuit Theory(Analysis and Synthesis) by A.Chakrabarthi,Dhanpat Rai&Co.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		0	0	3	1.5
ELECTRICAL ENGINEERING WORKSHOP (ES1218)					

Learning Objectives:

- To demonstrate the usage of measuring equipment
- To train the students in setting up simple wiring circuits
- To impart methods in electrical machine wiring

Any 10 of the following experiments are to be conducted

1. Study of various electrical tools and symbols.
2. Identify different types of cables/wires and switches, fuses & fuse carriers, MCGB and ELCB, MCCB with ratings and usage.
3. Identification of types of resistors and capacitors.
4. Wiring of light/fan circuit using two way/ three way control (stair case wiring)
5. Go-down wiring/Tunnel wiring
6. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and energy.
7. Measurement of voltage, current, resistance in DC circuit.
8. Measurement of voltage, calculate the power factor of the circuit.
9. Wiring of backup power supply including inverter, battery and load for domestic.
10. Types of earthing, physical implementation.
11. Identification of terminals of different semiconductor devices.
12. Identification of the peripherals of a computer. To prepare a report containing the block diagram of the CPU along with the configuration of each peripheral and its functions.Description of various I/O devices, power rating of computers.
13. A practice on disassembling the components of a PC and Assembling them to back to working condition.
14. Hardware trouble shooting (Demonstration): Identification of a problem and fixing a defective PC (improper assembly of peripherals).
15. Software troubleshooting (Demonstration): Identification of a problem and fixing the PC for any software issues.

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Learning Outcomes:

- Explain the limitations, tolerances, safety aspects of electrical systems and wiring.
- Select wires/cables and other accessories used in different types of wiring.
- Make simple lighting and power circuits.
- Measure current, voltage and power in a circuit.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		0	0	3	1.5
APPLIED PHYSIC LAB (ES1205)					

(Any 10 of the following listed 15 experiments)

LIST OF EXPERIMENTS:

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
5. Energy Band gap of a Semiconductor p - n junction.
6. Characteristics of Thermistor – Temperature Coefficients
7. Determination of dielectric constant by charging and discharging method
8. Determination of resistivity of semiconductor by Four probe method.
9. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
10 Measurement of magnetic susceptibility by Gouy's method.
11. Dispersive power of diffraction grating.
12. Resolving Power of telescope
13. Resolving power of grating
14. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall effect.
15. Variation of dielectric constant with temperature.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		0	1	2	2
COMMUNICATION SKILLS LAB (HS1203)					

UNIT I:
Oral Activity: JAM, Hypothetical Situations, Self/Peer Profile
Common Errors in Pronunciation, Neutralising Accent

UNIT II:
Oral Activity: Telephonic Etiquette, Role Plays
Poster Presentations

UNIT III:
Oral Activity: Oral Presentation skills, Public speaking
Data Interpretation

UNIT IV:
Oral Activity: Group Discussions: Do's and Don'ts- Types, Modalities

UNIT V:
Oral Activity: Interview Skills: Preparatory Techniques, Frequently asked questions, Mock Interviews.
Pronunciation: Connected speech (Pausing, Tempo, Tone, Fluency etc.,)

References:

1. Infotech English, Maruthi Publications (with Compact Disc).
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
5. English Pronunciation in use- Mark Hewings, Cambridge University Press.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.
8. Technical Communication- Meenakshi Raman, Sangeeta Sharma, Oxford University Press.
9. Technical Communication- Gajendrea Singh Chauhan, Smita Kashiramka, Cengage Publications.

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COURSE STRUCTURE-R19

I Year - II Semester		L	T	P	C
		0	0	2	1
ENGINEERING EXPLORATION PROJECT (PR1201)					

COURSE OBJECTIVES:

- Build mindsets & foundations essential for designers
- Learn about the Human-Centered Design methodology and understand their real-world applications
- Use Design Thinking for problem solving methodology for investigating illdefined problems.
- Undergo several design challenges and work towards the final design challenge

Apply Design Thinking on the following Streams to

- Project Stream 1: Electronics, Robotics, IOT and Sensors
- Project Stream 2: Computer Science and IT Applications
- Project Stream 3: Mechanical and Electrical tools
- Project Stream4: Eco-friendly solutions for waste management, infrastructure, safety, alternative energy sources, Agriculture, Environmental science and other fields of engineering.

HOW TO PURSUE THE PROJECT WORK?

- The first part will be learning-based-masking students to embrace the methodology by exploring all the phases of design thinking through the wallet/ bag challenge and podcasts.
- The second part will be more discussion-based and will focus on building some necessary skills as designers and learning about complementary material for human- centered design.
- The class will then divide into teams and they will be working with one another for about 2 – 3 weeks. These teams and design challenges will be the basis for the final project and final presentation to be presented.
- The teams start with **Design Challenge** and go through all the phases more in depth from coming up with the right question to empathizing to ideating to prototyping and to testing.
- Outside of class, students will also be gathering the requirements, identifying the challenges, usability, importance etc
- At the end, Students are required to submit the final reports, and will be evaluated by the faculty.

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TASKS TO BE DONE:

Task 1: Everyone is a Designer
- Understand class objectives & harness the designer mindset

Task 2: The Wallet/Bag Challenge and Podcast
- Gain a quick introduction to the design thinking methodology
- Go through all stages of the methodology through a simple design challenge
- Podcast: Observe, Listen and Engage with the surrounding environment and identify a design challenge.

Task 3: Teams & Problems
- Start Design Challenge and learn about teams & problems through this
- Foster team collaboration, find inspiration from the environment and learn how to identify problems

Task 4: Empathizing
- Continue Design Challenge and learn empathy
- Learn techniques on how to empathize with users
- Go to the field and interview people in their environments
- Submit Activity Card

Task 5: Ideating
- Continue Design Challenge and learn how to brainstorm effectively
- Encourage exploration and foster spaces for brainstorming
- Submit Activity Card

Task 6: Prototyping
- Continue Design Challenge and learn how to create effective prototypes
- Build tangible models and use them as communication tools
- Start giving constructive feedback to classmates and teammates
- Submit Activity Card

Task 7: Testing
- Finish Design Challenge and iterate prototypes and ideas through user feedback
- Evolve ideas and prototypes through user feedback and constructive criticism
- Get peer feedback on individual and group performance
- Submit Activity Card

Task 8:
- Final Report Submission and Presentation

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Note: The colleges may arrange for Guest Speakers from Various Design Fields: Graphic Design, Industrial Design, Architecture, Product Design, Organizational Design, etc to enrich the students with Design Thinking Concept.

REFERENCES:

1. Tom Kelly, The Art of Innovation: Lessons in Creativity From IDEO, America's Leading Design Firm (Profile Books, 2002)
2. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation (HarperBusiness, 2009)
3. Jeanne Liedtka, Randy Salzman, and Daisy Azer, Design Thinking for the Greater Good: Innovation in the Social Sector (Columbia Business School Publishing, 2017)

OTHER USEFUL DESIGN THINKING FRAMEWORKS AND METHODOLOGIES:

- Human-Centered Design Toolkit (IDEO); https://www.ideo.com/post/design-kit
- Design Thinking Boot Camp Bootleg (Stanford D-School); https://dschool.stanford.edu/resources/the-bootcamp-bootleg
- Collective Action Toolkit (frogdesign); https://www.frogdesign.com/wpcontent/
  - uploads/2016/03/CAT_2.0_English.pdf
- Design Thinking for Educators (IDEO); https://designthinkingforeducators.com/

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COURSE STRUCTURE-R19

II Year – I SEMESTER		L	T	P	C
		3	0	0	3
	ELECTRICAL CIRCUIT ANALYSIS-II				

Preamble :
This course aims at study of three phase systems, transient analysis, network synthesis and fourier analysis for the future study and analysis of power systems.

Learning Objectives:

- To study the concepts of balanced and unbalanced three-phase circuits.
- To study the transient behavior of electrical networks with DC, pulse and AC excitations.
- To study the performance of a network based on input and output excitation/response.
- To understand the realization of electrical network function into electrical equivalent passive elements.
- To understand the application of fourier series and fourier transforms for analysis of electrical circuits.

UNIT-I:
Balanced Three phase circuits
Phase sequence, star and delta connection of sources and loads, relation between line and phase voltages and currents.
Analysis of three phase balanced and unbalanced circuits. Loop method, Star-Delta transformation technique, two wattmeter method for measurement of three phase power.

UNIT-II:
Transient Analysis in DC and AC circuits
Transient response of R-L, R-C, R-L-C circuits for DC and AC excitations, solution using differential equations and Laplace transforms.

UNIT-III:
Two Port Networks
Two port network parameters – Z, Y, Transmission and Inverse Transmission parameters, Hybrid and Inverse hybrid parameters.
Relationships between parameter sets simplification of cascaded and parallel networks.

UNIT-IV:
Fourier analysis

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Fourier theorem – trigonometric form and exponential form of Fourier series, conditions of symmetry – line spectra and phase angle spectra, analysis of electrical circuits to non- sinusoidal periodic waveforms.

UNIT-V:
Fourier Transforms
Fourier integrals and Fourier transforms – properties of Fourier transforms physical significance of the Fourier transform and its application to electrical circuits.

Learning Outcomes:
After the completion of the course the student should be able to:

- solve three- phase circuits under balanced and unbalanced condition.
- find the transient response of electrical networks for different types of excitations.
- find parameters for different types of network.
- realize electrical equivalent network for a given network transfer function.
- extract different harmonics components from the response of an electrical network.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6 th edition
2. Network synthesis: Van Valkenburg: Prentice-Hall of India Private Ltd.

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, Mc Graw Hill Education (India)
2. Introduction to circuit analysis and design by Tildon Glisson. Jr, Springer Publications.
3. Circuits by A.Bruce Carlson , Cengage Learning Publications
4. Network Theory Analysis and Synthesis by Smarajit Ghosh, PHI publications
5. Networks and Systems by D. Roy Choudhury, New Age International publishers
6. Electric Circuits by David A. Bell, Oxford publications
7. Circuit Theory (Analysis and Synthesis) by A.Chakrabarthi,Dhanpat Rai&Co.

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COURSE STRUCTURE-R19

II Year – I SEMESTER		L	T	P	C
		3	0	0	3
	ELECTRICAL MACHINES – I				

Preamble:
This is a basic course on rotating electrical machines. This course covers the topics related to principles, performance, applications and design considerations of dc machines and transformers.

Learning objectives:
- Understand the construction, principle of operation and performance of DC machines.
- Learn the characteristics, performance, methods of speed control and testing methods of DC motors.
- To predetermine the performance of single phase transformers with equivalent circuit models.
- Understand the methods of testing of single-phase transformer.
- Analyze the three phase transformers and achieve three phase to two phase conversion.

UNIT–I:
Construction and Operation of DC machines
Construction and principle of operation of DC machine – emf equation for generator – classification of DC machines based on excitation – OCC of DC shunt generator – applications of DC Generators

UNIT–II:
Performance of DC Machines
Torque and back- emf equations of dc motors – Armature reaction and commutation – characteristics of separately-excited, shunt, series and compound motors – losses and efficiency – applications of dc motors.

UNIT-III:
Starting, Speed Control and Testing of DC Machines
Necessity of a starter – starting by 3 point and 4 point starters – speed control by armature voltage and field control.
Testing of DC machines – brake test, Swinburne's method – principle of regenerative or Hopkinson's method – retardation test – separation of losses.

UNIT–IV:
Single-phase Transformers
Types and constructional details – principle of operation – emf equation – operation on no load and on load –phasor diagrams of transformers - equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – all day efficiency.

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UNIT-V

Testing of Transformers and 3-Phase Transformers

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses- parallel operation with equal voltage ratios – auto transformer –comparison with two winding transformers.

Polyphase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ – Scott connection.

Learning outcomes:

After the completion of the course the student should be able to:

- assimilate the concepts of electromechanical energy conversion.
- mitigate the ill-effects of armature reaction and improve commutation in dc machines.
- understand the torque production mechanism and control the speed of dc motors.
- analyze the performance of single phase transformers.
- predetermine regulation, losses and efficiency of single phase transformers.
- parallel transformers, control voltages with tap changing methods and achieve three-phase to two-phase transformation.

Text Books:

1. Electrical Machines by P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald,Charles kingsley,Stephen D.Umans, TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,Mc Graw Hill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications, 5th edition.
3. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015
4. Electrical Machinery Fundamentals by Stephen J Chapman Mc Graw Hill education 2010
5. Electric Machines by Mulukutla S.Sarma&Mukesh k.Pathak, CENGAGE Learning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria & Sons

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COURSE STRUCTURE-R19

II Year – I SEMESTER		L	T	P	C
		3	0	0	3
	ELECTRONIC DEVICES AND CIRCUITS				

Preamble:
This course introduces the concepts of semi-conductor physics and operation of various semi-conductor devices. Realization of rectifiers, amplifiers and oscillators using semi-conductor devices, transistors and their analysis is introduced in this course.

Learning Objectives:

- The basic concepts of semiconductor physics are to be reviewed.
- Study the physical phenomena such as conduction, transport mechanism and electrical characteristics of different diodes.
- The application of diodes as rectifiers with their operation and characteristics with and without filters are discussed.
- The principal of working and operation of Bipolar Junction Transistor and Field Effect Transistor and their characteristics are explained.
- The need of transistor biasing and its significance is explained. The quiescent point or operating point is explained.
- Small signal equivalent circuit analysis of BJT and FET transistor amplifiers in different configuration is explained.

UNIT-I:

Semiconductor Physics : Insulators, Semiconductors, and Metals classification using energy band diagrams, mobility and conductivity, electrons and holes in intrinsic semi conductors, extrinsic semi conductors, drift and diffusion, charge densities in semiconductors, Hall effect, continuity equation, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors

Junction Diode Characteristics : Open circuited P-N junction, Biased P-N junction, P-N junction diode, current components in PN junction Diode, diode equation, V-I characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance, energy band diagram of PN junction Diode.

UNIT-II:

Special Semiconductor Diodes: Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Photodiode, Tunnel Diode, SCR, UJT. (Construction, operation and characteristics of all the devices are required to be considered).

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COURSE STRUCTURE-R19

Rectifiers and Filters: Basic Rectifier setup**,** half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, rectifier circuits-operation, input and output waveforms, Filters, Inductor filter, Capacitor filter, comparison of various filter circuits in terms of ripple factors.

UNIT- III: Transistor Characteristics:
BJT: Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through reach through, Photo transistor, typical transistor junction voltage values.
FET: FET types, construction, operation, characteristics, parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

UNIT- IV: Transistor Biasing and Thermal Stabilization : Need for biasing, operating point, load line analysis, BJT biasing- methods, basic stability, fixed bias, collector to base bias, self bias, Stabilization against variations in V_{BE}, Ic, and β, Stability factors, (S, S', S''), Bias compensation, Thermal runaway, Thermal stability.FET Biasing- methods and stabilization.

UNIT- V: Small Signal Low Frequency Transistor Amplifier Models:
BJT: Two port network, Transistor hybrid model, determination of h-parameters, conversion of h-parameters, generalized analysis of transistor amplifier model using h-parameters, analysis of CB, CE and CC amplifiers using exact and approximate analysis, comparison of transistor amplifiers.
FET: Generalized analysis of small signal model, analysis of CG, CS and CD amplifiers, comparison of FET amplifiers.

Learning Outcomes
After the completion of the course the student should be able to:

- understand the concepts of Semiconductor Technology.
- appraise the construction & operation of electronic devices.
- develop the biasing circuits using the electronic devices.
- model the amplifier circuits.
- analyse the characteristics of the devices.

Text Books:

1. Electronic Devices and Circuits- J. Millman, C. Halkias, Tata Mc-Graw Hill, Second Edition.
2. Electronics devices & circuit theory- Robert L.Boylestad and Loui Nashelsky, Pearson/Prentice hall, tenth edition

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References Books:

1. Electronic Devices and Circuits- Salivahanan, Kumar, Vallavaraj, Tata Mc-Graw Hill, Second Edition..
2. Electronic Devices and Circuits – David Bell, Oxford

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II Year – I SEMESTER		L	T	P	C
		3	0	0	3
	ELECTROMAGNETIC FIELDS				

Preamble:

Electromagnetic field theory is the pre-requisite for most of the subjects in the gamut of electrical engineering. The study of this subject enables students to understand and interpret the phenomenon pertinent to electrical engineering using microscopic quantities such as electric and magnetic field intensities, scalar and vector potentials.

Learning objectives:

- To study the production of electric field and potentials due to different configurations of static charges.
- To study the properties of conductors and dielectrics, calculate the capacitance of different configurations. Understand the concept of conduction and convection current densities.
- To study the magnetic fields produced by currents in different configurations, application of Ampere's law and the Maxwell's second and third equations.
- To study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other current loops.
- To develop the concept of self and mutual inductances and the energy stored.
- To study time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the induced EMF

UNIT – I:
Electrostatics
Scalar and vector fields, overview of coordinate system, calculus of scalar and vector fields in Cartesian coordinates – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge, work done in moving a point charge in an electrostatic field, electric potential – properties of potential function – potential gradient, Guass's law –Laplace's and Poison's equations.

UNIT – II:
Conductors – Dielectrics and Capacitance
Electric dipole – dipole moment – potential and EFI due to an electric dipole, Torque on an Electric dipole in an electric field conductors and Insulators – their behaviour in electric field.
Polarization, boundary conditions between conductors to dielectric.Capacitance of parallel plates, spherical and coaxial cable, energy stored and energy density in a static electric field, equation of continuity.

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UNIT – III:
Magneto statics and Ampere's Law
Biot-Savart's law, Magnetic Field Intensity (MFI) – MFI due to a straight current carrying filament, MFI due to circular, square and solenoid current – carrying wire – relation between magnetic flux, magnetic flux density and MFI. Maxwell's second Equation, div(B)=0, Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long filament carrying conductor, point form of Ampere's circuital law, field due to a rectangular loops, Maxwell's third equation, Curl (H)=J.
Magnetic force, moving charges in a magnetic field – Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors, magnetic dipole and dipole moment – a differential current loop as a magnetic dipole – Torque on a current loop placed in a magnetic field.

UNIT – IV:
Self and mutual inductance
Self and mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT – V:
Time Varying Fields
Time varying fields: Faraday's laws of electromagnetic induction – its integral and point forms, Maxwell's fourth equation, Curl (E)=-∂B/∂t, statically and dynamically induced EMF.

Learning outcomes:
After the completion of the course the student should be able to:
- determine electric fields and potentials using Guass's law or solving Laplace's or Possion's equations, for various electric charge distributions.
- calculate and design capacitance, energy stored in dielectrics.
- calculate the magnetic field intensity due to current, the application of Ampere's law and the Maxwell's second and third equations.
- determine the magnetic forces and torque produced by currents in magnetic field
- determine self and mutual inductances and the energy stored in the magnetic field.
- calculate induced EMF, understand the concepts of displacement current and Poynting vector.

Text Books:
1. "Engineering Electromagnetics" by William H. Hayt & John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.

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Reference Books:

1. " Principles of Electro Magnetics" by Sadiku, Oxford Publications,4th edition
2. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt.Ltd, 2nd edition
3. "Electromagnetic Field Theory" by Yaduvir Singh,Pearson.
4. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan,Oxford higher Education.

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		L	T	P	C
II Year – I SEMESTER		**3**	**0**	**0**	**3**
	THERMAL AND HYDRO PRIME MOVERS				

Part-A: Thermal Prime Movers

Course Objectives: To make the student understand the types of prime movers, which can be connected to generators for power production and should obtain the skills of performing the necessary calculations with respect to the functioning of the prime movers.

UNIT I:

Objectives: To make the student learn about the constructional features, operational details of various types of internal combustion engines through the details of several engine systems and the basic air standard cycles, that govern the engines. Further, the student shall be able to calculate the performance of different types of internal combustion engines.

I.C Engines: Classification, working principles – valve and port timing diagrams – air standard cycles – Engine systems line fuel injection, carburetion, ignition, cooling and lubrication – Engine performance evaluation.

UNIT II:

Objectives: To train the student in the aspects of steam formation and its utilities through the standard steam data tables and charts. To make the student correlate between the air standard cycles and the actual cycles that govern the steam turbines. To train the student to calculate the performance of steam turbines using velocity diagrams.

Properties of Steam and use of Steam Tables- T-S and H-S Diagrams. Analysis of various Thermodynamic and processes under gone by Steam.

Vapor Power Cycles: Carnot Cycle-Rankine Cycle- Thermodynamic variables Effecting Efficiency and output of Rankine Cycle-. Analysis of simple Rankine Cycle and Re-heat cycle.

Steam Turbines: Schematic layout of steam power plant – Classification of steam Turbines – Impulse Turbine and Reaction Turbine - Compounding in Turbines – Velocity Diagrams for simple Impulse and Reaction Turbines – Work done & Efficiency.

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UNIT III:

Objectives: To impart the knowledge of gas turbine fundamentals, the governing cycles and the method to improve the efficiency of gas turbines.

Gas Turbines: Simple gas turbine plant-ideal cycle, closed cycle - open cycle – Efficiency, Work ratio and optimum pressure ratio for simple gas turbine cycle. Actual cycle, analysis of simple cycles & cycles with inter cooling, reheating and regeneration.

Part-B: Hydro Prime Movers

UNIT IV:

Objectives: to teach the student about the fundamental of fluid dynamic equations and its applications fluid jets. To impart the knowledge of various types of pumps, their constructional features, working and performance.

IMPACT OF JETS AND PUMPS: Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved). Pumps: Types of pumps, Centrifugal pumps: Main components, Working principle, Multi stage pumps, Performance and Characteristic curves.

UNIT V:

Objectives: To make the student learn about the constructional features, operational details of various types of hydraulic turbines. Further, the student shall be able to calculate the performance of hydraulic turbines.

HYDRAULIC TURBINES: Classifications of turbines; Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines; Governing of turbines; Performance and characteristic curves.

HYDRO POWER: Components of Hydro electric power plant; pumped storage systems, Estimation of water power potential ; Estimation of load on turbines load curve, load factor, capacity factor, utilization factor, diversity factor, load- duration curve, firm power, secondary power, prediction of load.

Text Books:

1. Thermal Engineering by Rajput, Lakshmi publications.
2. Thermal engineering by M.L.Mathur and F.S.Mehta, Jain Brothers.

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3. Hydraulics & Fluid Mechanics, P.N.Modi and S.M.Seth, Standard Book House, Delhi.

Reference Books:

1. Fluid Mechanic & Hydraulic Machinery, A.K.Jain, Khanna Publishers, Delhi.
2. "Fluid Mechanics" by Victor.L.Streeter.
3. "Introduction to Fluid Mechanics" Edward.J.Shaughnessy Jr.
4. "Fluid Mechanics & Its Applications", Vijay Gupta, Santosh.k.Gupta
5. "Fluid Mechanic & Fluid Power Engineering", Dr.D.S.Kumar
6. "Water Power Engineering", M.M.Desumukh

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II Year – I SEMESTER		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS					

Course Objectives:

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Theories of Production and Cost Analyses:

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.

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Unit – IV:
Introduction to Accounting & Financing Analysis:
Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

Unit – V:
Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

TEXT BOOKS:
A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

REFERENCES:
1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New edition edition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & Company Ltd,
4. MaheswariS.N,AnIntroduction to Accountancy, Vikas Publishing House Pvt Ltd
5. I.M Pandey, Financial Management , Vikas Publishing House Pvt Ltd
6. V. Maheswari, Managerial Economics, S. Chand & Company Ltd,

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II Year – I SEMESTER		L	T	P	C
		0	0	3	1.5
	THERMAL AND HYDRO LABORATORY				

Course Objective: To impart practical knowledge on the performance evaluation methods of various internal combustion engines, flow measuring equipment and hydraulic turbines and pumps.

NOTE: TO CONDUCT MINIMUM OF 12 EXPERIMENTS BY CONDUCTING MINIMUM OF SIX FROM EACH SECTION.

SECTION A - THERMAL ENGINEERING LAB

1. I.C. Engines valve / port timing diagrams.
2. I.C. Engines performance test on 4 -stroke Diesel engine.
3. I.C. Engines performance test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine
5. Determination of FP by retardation and motoring test on IC engine
6. I.C. Engine heat balance on petrol / Diesel engines.
7. Economical speed test of an IC engine
8. Study of boilers

SECTION B –HYDRAULIC MACHINES LAB

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Reciprocating Pump.
7. Calibration of Venturimeter.
8. Calibration of Orifice meter.
9. Determination of loss of head due to sudden contraction in a pipeline.

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II Year – I SEMESTER		L	T	P	C
		0	0	3	1.5
	ELECTRICAL CIRCUITS LABORATORY				

Learning objectives:

To verify and demonstrate various theorems, locus diagrams, resonance and two port networks. To determine self and mutual inductance of a magnetic circuit, parameters of a given coil and measurement of 3- phase power.

Any 10 of the following experiments are to be conducted:

1) Verification of Thevenin's and Norton's Theorems.
2) Verification of superposition theorem and maximum power transfer theorem
3) Verification of compensation theorem
4) Verification of reciprocity, Millmann's Theorems
5) Determination of time constants of R-L, R-C networks using CRO.
6) Series and parallel resonance
7) Determination of self, mutual inductances and coefficient of coupling
8) Z and Y Parameters
9) Transmissionand hybrid parameters
10) Parameters of a choke coil.
11) Determination of cold and hot resistance of an electric lamp.
12) Measurement of 3-phase power by two Wattmeter method for unbalanced loads

Learning outcomes:

The Student should be able to apply various theorems, determination of self and mutual inductances, two port parameters of a given electric circuits. Able to draw locus diagrams, waveforms and phasor diagrams for lagging and leading networks.

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II Year – I SEMESTER		L	T	P	C
		3	0	0	0

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

Course Objectives:
To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system

- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection
- To know the student traditional knowledge in different sector

Course Outcomes:
After completion of the course, students will be able to:

- Understand the concept of Traditional knowledge and its importance
- Know the need and importance of protecting traditional knowledge
- Know the various enactments related to the protection of traditional knowledge
- Understand the concepts of Intellectual property to protect the traditional knowledge

UNIT I
Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge
Learning Outcomes:
At the end of the unit, the student will able to:

- Understand the traditional knowledge.
- Contrast and compare characteristics importance kinds of traditional knowledge.
- Analyze physical and social contexts of traditional knowledge.
- Evaluate social change on traditional knowledge.

UNIT II
Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.
Learning Outcomes:
At the end of the unit, the student will able to:

- Know the need of protecting traditional knowledge.
- Apply significance of tk protection.

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- Analyze the value of tk in global economy.
- Evaluate role of government

UNIT III

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

Learning Outcomes:

At the end of the unit the student will able to:

- Understand legal framework of TK.
- Contrast and compare the ST and other traditional forest dwellers
- Analyze plant variant protections
- Evaluate farmers right act

UNIT IV

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Learning Outcomes:

At the end of the unit, the student will able to:

- Understand TK and IPR
- Apply systems of TK protection.
- Analyze legal concepts for the protection of TK.
- Evaluate strategies to increase the protection of TK.

UNIT V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Learning Outcomes:

At the end of the unit, the student will able to:

- Know TK in different sectors.
- Apply TK in engineering.
- Analyze TK in various sectors.
- Evaluate food security and protection of TK in the country.

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Reference Books:

1) Traditional Knowledge System in India, by Amit Jha, 2009.
2) Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, PratibhaPrakashan 2012.
3) Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
4) "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

e-Resources:

1) https://www.youtube.com/watch?v=LZP1StpYEPM
2) http://nptel.ac.in/courses/121106003/

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRICAL MEASUREMENTS AND INSTRUMENTATION					

Preamble:
This course introduces the principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Learning Objectives:
- To study the principle of operation and working of different types of instruments for measurement of Electrical Quantities.
- To study the working principle of operation of different types of instruments for measurement of power and power factor.
- To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
- To understand the principle of operation and working of transducers.
- To study the principle of operation and working of DVMS, Power analyser and applications of CRO.

UNIT–I:
Analog Ammeter and Voltmeters
Classification – deflecting, control and damping torques,– PMMC, moving iron type and electrostatic instruments, Construction, Torque equation, Range extension, Effect of temperature, Errors and compensations, advantages and disadvantages. Instrument transformers: Current Transformer and Potential Transformer-construction, theory, errors-Numerical Problems.

UNIT –II:
Analog Wattmeters and Power Factor Meters
Electrodynamometer type wattmeter (LPF and UPF), Power factor meters: Dynamometer and M.I type (Single phase and Three phase), construction, theory, torque equation, advantages and disadvantages -Numerical Problems.

UNIT – III:
Measurements of Electrical parameters
DC Bridges: Method of measuring low, medium and high resistance – sensitivity of Wheat stone's bridge, Kelvin's double bridge for measuring low resistance, Loss of charge method for measurement of high resistance, Megger – measurement of earth resistance - Numerical Problems.

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AC Bridges: Measurement of inductance – quality factor, Maxwell's bridge, Hay's bridge, Anderson's bridge, measurement of capacitance and loss angle, Desauty's bridge, Schering Bridge, Wagner's earthing device, Wien's bridge- Numerical Problems.

UNIT – IV:
Transducers
Definition, Classification, Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge, Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, Digital shaft encoders, Hall effect sensors- Numerical Problems.

UNIT – V:
Digital meters

Digital voltmeter – Successive approximation DVM, Ramp type DVM and Integrating type DVM – Digital frequency meter, Digital multimeter, Digital tachometer, Digital Energy Meter, LCR Q meter, Power Analyzer-Measurement of phase difference, Frequency, hysteresis loop using lissajious patterns in CRO- Numerical Problems.

Learning Outcomes:
After the completion of the course the student should be able to:

- choose right type of instrument for measurement of ac and dc Electrical quantities.
- choose right type of instrument for measurement of power and power factor.
- select right type for measurement of R, L,C.
- understand the effectiveness of Transducer.
- able to understand Digital Meters.

Text Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai & Co.Publications.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand.
3. Electrical Measurements by Buckingham and Price, Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons
5. Electrical Measurements: Fundamentals, Concepts, Applications by Reissland, M.U, New Age International (P) Limited, Publishers.
6. Electrical and Electronic Measurements by G.K.Banerjee, PHI Learning Private Ltd, New Delhi–2012.

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
	ELECTRICAL MACHINES – II				

Preamble:
This course covers the topics on 3-phase induction motor, 1-phase induction motor and synchronous machines which have wide application in power systems. The main aim of the course is to provide a detailed analysis of operation and performance of 3-phase induction motor, 1-phase induction motor and synchronous machines. In addition, it also covers voltage regulation and parallel operation of synchronous generators.

Learning objectives:
- Understand the principle of operation and performance of 3-phase induction motor.
- Quantify the performance of induction motor and induction generator in terms of torque and slip.
- To understand the torque producing mechanism of a single phase induction motor.
- To understand the principle of emf generation, the effect of armature reaction and predetermination of voltage regulation in synchronous generators.
- To study parallel operation and control of real and reactive powers for synchronous generators.
- To understand the operation, performance and starting methods of synchronous motors.

UNIT-I:
3-phase induction motors
Construction details of cage and wound rotor machines – production of rotating magnetic field – principle of operation – rotor emf and rotor frequency – rotor current and power factor at standstill and during running conditions – rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram

UNIT-II:
Characteristics, starting and testing methods of induction motors
Torque equation – expressions for maximum torque and starting torque – torque slip characteristic –double cage and deep bar rotors – crawling and cogging – speed control of induction motor with V/f control method –no load and blocked rotor tests – circle diagram for predetermination of performance – methods of starting –starting current and torque calculations – induction generator operation (Qualitative treatment only)

UNIT – III:
Single Phase Motors
Single phase induction motors – constructional features and equivalent circuit – problem of starting– double revolving field theory

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Starting methods, AC series motor.

UNIT–IV:
Construction, operation and voltage regulation of synchronous generator
Constructional features of non-salient and salient pole type armature windings – distributed and concentrated windings – distribution, pitch and winding factors – E.M.F equation – improvements of waveform and armature reaction – voltage regulation by synchronous impedance method –MMF method and Potier triangle method – phasor diagrams – two reaction analysis of salient pole machines and phasor diagram.
Parallel operation with infinite bus and other alternators – synchronizing power – load sharing – control of real and reactive power – numerical problems.

UNIT–V:
Synchronous motor – operation, starting and performance
Synchronous motor principle and theory of operation – phasor diagram – starting torque – variation of current and power factor with excitation –synchronous condenser – mathematical analysis for power developed– hunting and its suppression – methods of starting – applications.

Learning outcomes:
After the completion of the course the student should be able to:
- explain the operation and performance of three phase induction motor.
- analyze the torque-speed relation, performance of induction motor and induction generator.
- explain design procedure for transformers and three phase induction motors.
- implement the starting of single phase induction motors.
- perform winding design and predetermine the regulation of synchronous generators.
- avoid hunting phenomenon, implement methods of staring and correction of power factor with synchronous motor.

Text Books:
1. Electrical Machines by P.S. Bhimbra, Khanna Publishers
2. Electric Machinery by A.E.Fitzgerald,Charles kingsley,Stephen D.Umans, TMH

Reference Books:
1. Electrical Machines by D. P.Kothari, I .J .Nagarth,Mc Graw Hill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition
3. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015
4. Electrical Machinery Fundamentals by Stephen J Chapman Mc Graw Hill education 2010
5. Electric Machines by Mulukutla S.Sarma&Mukesh k.Pathak, CENGAGE Learning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria & Sons

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7. Alternating Current Machines by A.F.Puchstein, T.C. Lloyd, A.G. Conrad, ASIA Publishing House
7. Performance and design of AC machines – M.G. Say.

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
DIGITAL ELECTRONICS					

Preamble:
This course covers the topics related to representation numbers in different radix formats, complements and codes. It also introduces the basic gates and their realization in SOP and POS form. Boolean algebra and various logic gates minimization process is introduced. Design principles of combinational and sequential circuits are explained to make the students thorough in design of these circuits.

Course Objectives:
- To solve a typical number base conversion and analyze new error coding techniques.
- Theorems and functions of Boolean algebra and behavior of logic gates.
- To optimize logic gates for digital circuits using various techniques.
- To understand concepts of combinational circuits.
- To develop advanced sequential circuits.

UNIT – I:
Review of Number Systems & Codes:
Representation of numbers of different radix, conversation from one radix to another radix, r-1's compliments and r's compliments of signed numbers, problem solving. 4 bit codes, BCD, Excess-3, 2421, 84-2-1 9s & 10s compliment code etc.,

Logic operations and error detection & correction codes; Basic logic operations -NOT, OR, AND, Universal building blocks, EX-OR, EX-NOR - Gates, Standard SOP and POS, Forms, Gray code, error detection, error correction codes (parity checking, even parity, odd parity, Hamming code) NAND-NAND and NOR-NOR realizations.

UNIT – II:
Minimization Techniques
Boolean theorems, principle of complementation & duality, De-morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 6 variables, tabular minimization, problem solving (code-converters using K-Map etc..).

UNIT – III:
Combinational Logic Circuits Design

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Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders, 4-bit binary subtractor, adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit, look-a-head adder circuit, Design of decoder, demultiplexer, 7 segment decoder, higher order demultiplexing, encoder, multiplexer, higher order multiplexing, realization of Boolean functions using decoders and multiplexers, priority encoder, 4-bit digital comparator.

UNIT – IV:
Sequential Circuits I

Classification of sequential circuits (synchronous and asynchronous); basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals). Conversion from one flip-flop to another. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift register.

UNIT – V:
Sequential Circuits II

Finite state machine; Analysis of clocked sequential circuits, state diagrams, state tables, reduction of state tables and state assignment, design procedures. Realization of circuits using various flip-flops. Mellay to Moore conversion and vice-versa.

Course Outcomes:

After the completion of the course the student should be able to:

- classify different number systems and apply to generate various codes.
- use the concept of Boolean algebra in minimization of switching functions
- design different types of combinational logic circuits.
- apply knowledge of flip-flops in designing of Registers and counters
- the operation and design methodology for synchronous sequential circuits and algorithmic state machines.
- produce innovative designs by modifying the traditional design techniques.

Text Books:

1. Zvi kohavi and Niraj K.Jha, " Switching and finite Automata Theory", Cambridge University Press, 3rd edition, 2010.
2. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition.
3. Digital Design by M. Morrics Mano, Micheal D.Ciletti, Pearson Publication 4Th edition. PHI.

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4. Digital Principles And Applications by Albert Paul Malvino, Donald P Leach TMH edition.

Reference Books:

1. Switching Theory and Logic Design by A. Anand Kumar
2. Modern Digital Electronics by RP Jain, TMH
3. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers
4. Digital electronics logic and design-Cherry Bhargava, BS Publications, 2019.

Web Links:

1. https://www.youtube.com/watch?v=CeD2L6KbtVM
2. Lecture series on Digital Circuits & Systems by Prof.S.Srinivasan, Department of Electrical Engineering, IIT Madras.For more details on NPTEL visit http://nptel.iitm.ac.in
3. https://www.youtube.com/watch?v=K73N9ES_8nI
4. https://www.youtube.com/watch?v=62WxkICo2Bc

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		3	0	0	3
	CONTROL SYSTEMS				

Preamble:
This course introduces the elements of linear control systems and their analysis. Classical methods of design using frequency response. The state space approach for design, modeling and analysis of simple PD, PID controllers.

Learning Objectives:

- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers
- To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locus method.
- To discuss basic aspects of design and compensation of linear control system using Bode plot.
- To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots and Nyquist stability criterion.
- Ability to formulate state models and analyze the systems. To learn the concepts of Controllability and Observability.

UNIT – I:
Mathematical Modeling of Control Systems
Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems, transfer function of DC servo motor – AC servo motor – synchro, transmitter and receiver – block diagram algebra – representation by signal flow graph – reduction using Mason's gain formula.

UNIT-II:
Time Response Analysis
Standard test signals – time response of first and second order systems – time domain specifications, steady state errors and error constants, P, PI,

Stability and Root Locus Technique

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The concept of stability – Routh's stability criterion –limitations of Routh's stability, Root locus concept – construction of root loci (simple problems).Effect of addition of poles and zeros root locus

UNIT–III:

Frequency Response Analysis

Introduction to frequency domain specifications – Bode diagrams – transfer function from the Bode diagram – phase margin and gain margin – stability analysis from Bode plots.
Polar plots, Nyquist stability criterion.

UNIT–IV:

Classical Control Design Techniques

Lag, lead, lag-lead compensators, design of compensators using Bode plots.

UNIT–V:

State Space Analysis of LTI Systems

Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and it's Properties, concepts of controllability and observability.

Learning Outcome:

After the completion of the course the student should be able to:

- derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- determine time response specifications of second order systems and to determine error constants.
- analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- analyze the stability of LTI systems using frequency response methods.
- design Lag, Lead, Lag-Lead compensators to improve system performance from Bode diagrams.
- represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:

1. Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of India.
2. Automatic control systems by Benjamin C.Kuo, Prentice Hall of India,2nd Edition.

Reference Books:

1. Control Systems principles and design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4th Edition.
2. Control Systems by Manik Dhanesh N, Cengage publications.
3. Control Systems Engineering by I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
4. Control Systems Engineering by S.Palani,Tata Mc Graw Hill Publications.

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		3	0	0	3
	POWER SYSTEMS-I				

Preamble:
Electrical Power plays significant role in day to day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

Learning objectives :

- To study the principle of operation of different components of a thermal power stations.
- To study the principle of operation of different components of a Nuclear power stations.
- To study the constructional and operation of different components of an Air and Gas Insulated substations.
- To study the constructional details of different types of cables.
- To study different types of load curves and tariffs applicable to consumers.

UNIT-I:
Thermal Power Stations
Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system, Brief description of components: boilers, super heaters, economizers, electrostatic precipitators, steam turbines: impulse and reaction turbines, condensers, feed water circuit, cooling towers and chimney.

UNIT-II:
Nuclear Power Stations
Location of nuclear power plant, working principle, nuclear fission, nuclear fuels, nuclear chain reaction, nuclear reactor components: moderators, control rods, reflectors and coolants,types of nuclear reactors and brief description of PWR, BWR and FBR. Radiation: radiation hazards and shielding, nuclear waste disposal.

UNIT-III:
Substations
Classification of substations:
Air Insulated Substations – indoor & outdoor substations, substations layouts of 33/11 kV showing the location of all the substation equipment.
Bus bar arrangements in the sub-stations: simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.

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Gas Insulated Substations (GIS) – advantages of gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, constructional aspects of GIS, installation and maintenance of GIS, comparison of air insulated substations and gas insulated substations.

UNIT-IV:
Underground Cables
Types of cables, construction, types of insulating materials, calculation of insulation resistance, stress in insulation and power factor of cable.
capacitance of single and 3-Core belted Cables: Grading of cables – capacitance grading and intersheath grading.

UNIT-V:
Economic Aspects of Power Generation & Tariff
Economic Aspects –load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, power capacity factor and plant use factor, base and peak load plants.
Tariff Methods– costs of generation and their division into fixed, semi-fixed and running costs, desirable characteristics of a tariff method, tariff methods: simple rate, flat rate, block-rate, two-part, three–part, and power factor tariff methods.

Learning Outcomes:
After the completion of the course the student should be able to:
- identify the different components of thermal power plants.
- identify the different components of nuclear Power plants.
- identify the different components of air and gas insulated substations.
- identify single core and three core cables with different insulating materials.
- analyse the different economic factors of power generation and tariffs.

Text Books:
1. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers.

Reference Books:
1. Electrical Power Distribution Systems by V. Kamaraju, Tata Mc Graw Hill, New Delhi.
2. Elements of Electrical Power Station Design by M V Deshpande, PHI, New Delhi.

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II Year – II SEMESTER		L	T	P	C
		3	0	0	3
	SIGNALS AND SYSTEMS				

Preamble:

This course introduces the fundamental concepts of various types signals and their properties and mathematical operations on the signals. Fourier series, Fourier and Hilbert transforms are introduced to analyze the signals. Sampling theorem and Parsevel's theorem are introduced to design and analysis of filters. Laplace and Z-transforms are used for the analysis of signals.

Course Objectives:

- To introduce the terminology of signals and systems.
- To introduce Fourier tools through the analogy between vectors and signals.
- To introduce the concept of sampling and reconstruction of signals.
- To analyze the linear systems in time and frequency domains.
- To study z-transform as mathematical tool to analyze discrete-time signals and systems.

UNIT- I:

Introduction

Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions.

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UNIT –II:

Fourier Series And Fourier Transform:

Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Introduction to Hilbert Transform.

UNIT –III:

Sampling Theorem

Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling.

UNIT-IV:

Analysis of Linear Systems

Linear system, impulse response, Response of a linear system, Linear time invariant (LTI) system, Linear time variant (LTV) system, Concept of convolution in time domain and frequency domain, Graphical representation of convolution, Transfer function of a LTI system. Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Ideal LPF, HPF and BPF characteristics, Causality and Poly-Wiener criterion for physical realization, relationship between bandwidth and rise time.

Cross-correlation and auto-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation.

UNIT –V:

Laplace Transforms

Review of Laplace transforms, Partial fraction expansion, Inverse Laplace transform, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Relation between L.T's, and F.T. of a signal.

Z–Transforms

Fundamental difference between continuous-time and discrete-time signals,discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal, Concept of Z- Transform of a discrete sequence.

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Distinction between Laplace, Fourier and Z transforms. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms.

Course Outcomes:

After the completion of the course the student should be able to:

- characterize the signals and systems and principles of vector spaces, Concept of orthgonality.
- analyze the continuous-time signals and continuous-time systems using Fourier series, Fourier transform and Laplace transform.
- apply sampling theorem to convert continuous-time signals to discrete-time signal and reconstruct back.
- understand the relationships among the various representations of LTI systems
- understand the Concepts of convolution, correlation, Energy and Power density spectrum and their relationships.
- apply z-transform to analyze discrete-time signals and systems.

Text Books:

1.Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
2.Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn.
3.Signals & Systems- Narayan Iyer and K Satya Prasad, Cenage Pub.

Reference Books:

1.Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition.
2.Principles of Linear Systems and Signals – BP Lathi, Oxford University Press, 2015
3.Signals and Systems – Signals and Systems – M.J. Roberts,3rd Edition,MC Graw-Hill,2019.
4.Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, 2008.
5.Signals and Systems – T K Rawat , Oxford University press, 2011

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II Year – II SEMESTER		L	T	P	C
		0	0	3	1.5
ELECTRICAL MACHINES – I LABORATORY					

Learning objectives:

- To plot the magnetizing characteristics of DC shunt generator and understand the mechanism of self-excitation.
- To control the speed of DC motors.
- To determine and predetermine the performance of DC machines.
- To predetermine the efficiency and regulation of transformers and assess their performance.

Any 10 of the following experiments are to be conducted

1. Magnetization characteristics of DC shunt generator.
2. Brake test on DC shunt motor.
3. Hopkinson's test on DC shunt machines.
4. Swinburne's test and Predetermination of efficiencies as Generator and Motor.
5. Speed control of DC shunt motor by Field and Armature Control.
6. Retardation test on DC shunt motor..
7. Separation of losses in DC shunt motor.
8. OC & SC test on single phase transformer.
9. Sumpner's test on single phase transformer.
10. Scott connection of transformers
11. Parallel operation of Single phase Transformers
12. Separation of core losses of a single phase transformer
13. Heat run test on a bank of 3 Nos. of single phase Delta connected transformers

Learning outcomes:

After the completion of the course the student should be able to:

- Determine and predetermine the performance of DC machines and Transformers.
- Control the speed of DC motor.
- Obtain three phase to two phase transformation.

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II Year – II SEMESTER		L	T	P	C
		0	0	3	1.5
ELECTRONIC DEVICES & CIRCUITS LABORATORY					

Electronic Workshop Practice:

1.Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Coils, Gang condensers, Relays, Bread Boards.
2.Identification,Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
3.Soldering Practice- Simple circuits using active and passive components.
4.Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function
5.Generator, Regulated Power Supply and CRO..

List of Experiments

Any 10 of the following experiments are to be conducted

1. P.N Junction Diode Characteristics
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2.Zener Diode Characteristics
Part A: V-I Characteristic
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
   Part A: Half-wave Rectifier
   Part B : Full-wave Rectifier
4.BJT Characteristics (CE Configuration)
   Part A: Input Characteristics
   Part B: output Characteristics
5.FET Characteristics
   Part A: Drain Characteristics
   Part B: Transfer Characteristics
6.SCR Characteristics
7.UJT Characteristics
8.Transistor Biasing
9.CRO Operation and its Measurement
10. BJT-CE Amplifier
11.Emitter Follower –CC Amplifier

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12.FET-CS Amplifier

Note: The students are required to perform the experiment to obtain the V-I characteristics and to determine the relevant parameters from the obtained graphs.

Equipment required:

1.Regulated Power supplies
2.Analog/Digital Storage Oscilloscopes
3.Analog/Digital Function Generators
4.Digital Multimeters
5.Decade Résistance Boxes/Rheostats
6.Decade Capacitance Boxes
7.Ammeters (Analog or Digital)
8.Voltmeters (Analog or Digital)
9.Active & Passive Electronic Components

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II Year – II SEMESTER		L	T	P	C
		3	0	0	0
PROFESSIONAL ETHICS AND HUMAN VALUES					

Course Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty
- To appreciate the rights of others
- To create awareness on assessment of safety and risk

Course outcomes:

Students will be able to:

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

UNIT I

Human Values: Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others –Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation– Commitment – Empathy –Self Confidence Character –Spirituality.

Learning outcomes:

1. Learn about morals, values & work ethics.
2. Learn to respect others and develop civic virtue.
3. Develop commitment
4. Learn how to live peacefully

UNIT II

Engineering Ethics: Senses of 'Engineering Ethics-Variety of moral issued –Types of inquiry – Moral dilemmas –Moral autonomy –Kohlberg's theory-Gilligan's theory-Consensus and controversy –Models of professional roles-Theories about right action-Self-interest -Customs and religion –Uses of Ethical theories –Valuing time –Cooperation –Commitment.

Learning outcomes:

1. Learn about the ethical responsibilities of the engineers.
2. Create awareness about the customs and religions.

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3. Learn time management
4. Learn about the different professional roles.

UNIT III

Engineering as Social Experimentation**:** Engineering As Social Experimentation –Framing the problem –Determining the facts –Codes of Ethics –Clarifying Concepts –Application issues – Common Ground -General Principles –Utilitarian thinking respect for persons.

Learning outcomes:

1. Demonstrate knowledge to become a social experimenter.
2. Provide depth knowledge on framing of the problem and determining the facts.
3. Provide depth knowledge on codes of ethics.
4. Develop utilitarian thinking

UNIT IV

Engineers Responsibility for Safety and Risk: Safety and risk –Assessment of safety and risk – Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights (IPR).

Learning outcomes:

1. Create awareness about safety, risk & risk benefit analysis.
2. Engineer's design practices for providing safety.
3. Provide knowledge on intellectual property rights.

UINIT V

Global Issues: Globalization –Cross-culture issues-Environmental Ethics –Computer Ethics – Computers as the instrument of Unethical behavior –Computers as the object of Unethical acts – Autonomous Computers-Computer codes of Ethics –Weapons Development -Ethics and Research –Analyzing Ethical Problems in research.

Learning outcomes:

1. Develop knowledge about global issues.
2. Create awareness on computer and environmental ethics
3. Analyze ethical problems in research.
4. Give a picture on weapons development.

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Text Books:

1) "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and, V.S.Senthil Kumar-PHI Learning Pvt. Ltd-2009
2) "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3) "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger –Tata McGraw-Hill– 2003.
4) "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-Maruthi Publications.
5) "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran-LaxmiPublications.
6) "Professional Ethics and Human Values" by Prof.D.R.Kiran-

"Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
	POWER SYSTEMS–II				

Preamble:
This course is an extension of power systems–I course. It deals with basic theory of transmission lines modeling and their performance analysis. Transient in power system, improvement of power factor and voltage control are discussed in detail. It is important for the student to understand the mechanical design aspects of transmission lines, cables, insulators. These aspects are also covered in detail in this course.

Learning Objectives:
- To compute inductance/capacitance of transmission lines and to understand the concepts of GMD/GMR.
- To study the short and medium length transmission lines, their models and performance.
- To study the performance and modeling of long transmission lines.
- To study the effect of travelling waves on transmission lines.
- To study the factors affecting the performance of transmission lines and power factor improvement methods.
- To discuss sag and tension computation of transmission lines as well as to study the performance of overhead insulators.

UNIT–I:
Transmission Line Parameters
Conductor materials - Types of conductors – Calculation of resistance for solid conductors – Calculation of inductance for single phase and three phase– Single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors – Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and three phase–Single and double circuit lines- Bundled conductors.

UNIT–II:
Performance Analysis of Transmission Lines
Classification of Transmission Lines – Short, medium, long line and their model representations –Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks.

Rigorous Solution for long line equations – Surge Impedance and SIL of Long Lines – Representation of Long lines – Equivalent T and Equivalent Pie network models - Mathematical Solutions to estimate regulation and efficiency of all types of lines.

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UNIT – III:
Power System Transients
Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients – Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions.

UNIT–IV:
Various Factors governing the Performance of Transmission line
Skin and Proximity effects – Description and effect on Resistance of Solid Conductors –Ferranti effect – Charging Current – Corona – Description of the phenomenon–Factors affecting corona– Critical voltages and power loss – Radio Interference.

UNIT–V:
Sag and Tension Calculations and Overhead Line Insulators
Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor – Stringing chart and sag template and its applications–Types of Insulators – String efficiency and Methods for improvement - Voltage distribution–Calculation of string efficiency – Capacitance grading and Static Shielding.

Learning Outcomes:
After the completion of the course the student should be able to:
- understand parameters of various types of transmission lines during different operating conditions.
- understand the performance of short and medium transmission lines.
- understand travelling waves on transmission lines.
- understand various factors related to charged transmission lines.
- understand sag/tension of transmission lines and performance of line insulators.

Text Books:
1. Electrical power systems – by C.L.Wadhwa, New Age International (P) Limited, Publishers, 1998.
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition

Reference Books:
1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition
2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar A.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.
4. Electrical Power Systems by P.S.R. Murthy, B.S.Publications.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
	POWER ELECTRONICS				

Preamble:
The usage of power electronics in day to day life has increased in recent years. It is important for student to understand the fundamental principles behind all these converters. This course covers characteristics of semiconductor devices, ac/dc, dc/dc, ac/ac and dc/ac converters. The importance of using pulse width modulated techniques to obtain high quality power supply (dc/ac converter) is also discussed in detail in this course.

Learning Objectives:
- To study the characteristics of various power semiconductor devices and to design firing circuits for SCR.
- To understand the operation of single phase full–wave converters and analyze harmonics in the input current.
- To study the operation of three phase full–wave converters.
- To understand the operation of different types of DC-DC converters.
- To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.
- To analyze the operation of AC-AC regulators.

UNIT–I:
Introduction
Basic Theory of Operation - Static Characteristics-Two Transistors analogy -Turn on and Turn off Methods - Methods of SCR Triggering - Dynamic & Gate Characteristics of SCR - Series and Parallel Operation - Snubber circuit - Characteristics of Power MOSFET and IGBT.

UNIT–II:
Single Phase AC-DC Converters
Single Phase half wave controlled rectifiers - R load and RL load with and without freewheeling diode - Single Phase fully controlled bridge converter with R load, RL load and RLE load - Continuous and Discontinuous conduction - Effect of source inductance in 1-phase fully controlled bridge rectifier with continuous conduction – Expression for output voltages – Single Phase semi Converter with R load, RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis - Single Phase Dual Converters - Numerical Problems

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UNIT–III:
Three Phase AC-DC Converters & AC – AC Converters
Three Phase half wave Rectifier with R and RL load -Three Phase fully controlled rectifier with R and RL load - Three Phase semi converter with R and RL load - Expression for Output Voltage - Harmonic Analysis - Three Phase Dual Converters - Numerical Problems.

AC-AC power control by phase control with R and RL loads - Three phase AC voltage regulator with R load – Single phase step down Cycloconverter - Numerical Problems.

UNIT–IV:
DC–DC Converters
Operation of Basic Chopper - Classification - Control Techniques - Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple- Numerical Problems.

UNIT – V:
DC–AC Converters
Introduction - Classification - Single Phase half bridge and full bridge inverters with R and RL loads - Unipolar & Bipolar Switching - Quasi-square wave pulse width modulation - Three Phase square wave inverters - 120^0 conduction and 180^0 conduction modes of operation - PWM inverters - Sinusoidal Pulse Width Modulation - Current Source Inverter (CSI) - Numerical Problems.

Learning Outcomes:
After the completion of the course the student should be able to:

- explain the characteristics of various power semiconductor devices and analyze the static and dynamic characteristics of SCR's.
- design firing circuits for SCR.
- explain the operation of single phase full–wave converters and analyze harmonics in the input current.
- explain the operation of three phase full–wave converters.
- analyze the operation of different types of DC-DC converters.
- explain the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.
- analyze the operation of AC-AC regulators.

Text Books:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, John Wiley & Sons.

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2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998
3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein.oxford.
2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics: by Daniel W.Hart, Mc Graw Hill.

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
	LINEAR IC APPLICATIONS				

Preamble:

To understand the various possible applications of integrated circuits this course is proposed. To attend this course, it is assumed that all the students taking this course should have the basic electronic circuits' concepts. In the course content, basic characteristics required to use integrated circuits for various applications are included, followed by the linear and nonlinear applications of operational amplifiers. In addition, application of integrated circuits in filter design, modulators, analog multiplier, timer and phase locked loops applications. Application of integrated circuits for analog-to-digital and digital-to-analog conversion is also included.

Learning Objectives:

- To understand the basic operation &performance parameters of differential amplifiers.
- To understand & learn the measuring techniques of performance parameters of Op-Amp
- To learn the linear and non-linear applications of operational amplifiers.
- To understand the analysis & design of different types of active filters using Op-Amps
- To learn the internal structure, operation and applications of different analog ICs
- To Acquire skills required for designing and testing integrated circuits

UNIT I

Characteristics of OP-Amps:

Characteristics of OP-Amps, Integrated circuits-Types, Classification, Package Types and Temperature ranges, Power supplies, Op-Amp Block Diagram, ideal and practical Op-amp Specifications, DC and AC characteristics, 741 op-amp & its features, Op-Amp parameters & Measurement, Input & Out put Off set voltages & currents, slew rate, CMRR, PSRR, drift, Frequency Compensation techniques.

UNIT II

Linear And Non-Linear Applications Of Op-Amps:

Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non- Linear function generation, Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti log Amplifiers, Precision rectifiers.

UNIT III

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Active Filters, Analog Multipliers And Modulators:
Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.
Four Quadrant Multiplier, IC 1496, Sample & Hold circuits.

UNIT IV
Timers & Phase Locked Loops:
Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger; PLL - introduction, block schematic, principles and description of

individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation, AM, FM & FSK demodulators. Applications of VCO (566).

UNIT V
Digital To Analog And Analog To Digital Converters:
Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC.DAC and ADC Specifications, Specifications AD 574 (12 bit ADC).

Learning Outcomes:
After the completion of the course the student should be able to:

- design circuits using operational amplifiers for various applications.
- analyze and design amplifiers and active filters using Op-amp.
- diagnose and trouble-shoot linear electronic circuits.
- understand the gain-bandwidth concept and frequency response of the amplifier configurations.
- understand thoroughly the operational amplifiers with linear integrated circuits.

Text Books:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3. Operational Amplifiers–C.G. Clayton, Butterworth & Company Publ. Ltd./Elsevier, 1971

References Books:

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma ;SK Kataria &Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.

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3. OP AMPS and Linear Integrated Circuits concepts and Applications, James M Fiore, Cenage Learning India Ltd.
4. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin & Fredrick Driscoll, PHI, 6th Edition.
5. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition

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COURSE STRUCTURE-R19

III Year – I SEMESTER		L	T	P	C
		3	0	0	3
	DIGITAL SIGNAL PROCESSING				

Preamble:
The course has been designed to cater to the needs of electronic industry transforms. This course covers basic concepts of signal processing, various transformation techniques. It provides students to relies about different filter structure and also coding of speech signals.

Learning Objectives:

- To explore the basic concepts of digital signal processing.
- To connect the time domain signal to frequency domain signals using fourier transform.
- To understand the basic structures of IRR systems.
- To understand and design FIR Digital filters.
- To explore the concepts of multiple sampling rates for DSP.

UNIT-I:
Introduction
Introduction to Digital Signal Processing: Discrete time signals & sequences, Classification of Discrete time systems, stability of LTI systems, Invertability, Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms, solution of difference equations using Z-transforms, System function.

UNIT-II:
Discrete Fourier Series & Fourier Transforms
Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

UNIT-III:
Design of IIR Digital Filters& Realizations
Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

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UNIT-IV:
Design of FIR Digital Filters & Realizations
Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique, Comparison of IIR & FIR filters.
Basic structures of FIR systems, Lattice structures, Lattice-ladder structures
UNIT-V:
Multirate Digital Signal Processing
Introduction, Decimation, Interpolation Sampling rate conversion, Implementation of sampling rate converters, Applications – Sub-band Coding of Speech Signals, Implementation of Digital Filter Banks, Trans-multiplexers.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand the concepts of signal processing& transforms.
- appraise the Fat Fourier algorithm.
- design FIR and IIR filters.
- appreciate the concepts of multirate signal processing.

Text Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis Dimitris G.Manolakis, Pearson Education / PHI, 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI.
3. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007.
3. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.
5. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006

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III Year – I SEMESTER		L	T	P	C
		3	0	0	3
MICROPROCESSORS AND MICROCONTROLLERS					

Preamble:
Microprocessor and Microcontroller have become important building blocks in digital electronics design. It is important for student to understand the architecture of a microprocessor and its interfacing with various modules. 8086 microprocessor architecture, programming, and interfacing is dealt in detail in this course. Interfacing, PIC, architecture, programming in C.

Learning objectives:
- To understand the organization and architecture of Microprocessor
- To understand addressing modes to access memory
- To understand 8051 micro controller architecture
- To understand the programming principles for 8086 and 8051
- To understand the interfacing of MP with IO as well as other devices
- To understand how to develop cyber physical systems

UNIT–I:
Introduction to Microprocessor Architecture
Introduction and evolution of Microprocessors – Architecture of 8086 – Memory Organization of 8086 – Register Organization of 8086 – Instruction sets of 8086 – Addressing modes – Assembler directives – Introduction to 80286, 80386, 80486 and Pentium (brief description about architectural advancements only).

UNIT–II:
Minimum and Maximum Mode Operations
General bus operation of 8086 – Minimum and Maximum mode operations of 8086 – 8086 Control signal interfacing – Read and write cycle timing diagrams.

Microprocessors I/O interfacing – I
8255 PPI– Architecture of 8255–Modes of operation– Interfacing I/O devices to 8086 using 8255–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing– Static memory interfacing with 8086.

UNIT–III:

Microprocessors I/O interfacing – II
Architecture and interfacing of 8251 USART – Architecture and interfacing of 8254 Timer/counter – Architecture and interfacing of DMA controller (8257) – Architecture 8259 Programmable Interrupt Controller (8259) – Command words and operating modes of 8259 –

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Interfacing of 8259 – Architecture of Keyboard/display controller (8279) – Modes of operation – Command words of 8279 – Interfacing of 8279.

UNIT–IV:
8051 Microcontroller:
Overview of 8051 Microcontroller – Architecture– Memory Organization – Register set – I/O ports and Interrupts – Timers and Counters – Serial Communication – Interfacing of peripherals-Instruction set.

UNIT– V:
PIC Architecture
Block diagram of basic PIC 18 micro controller – registers I/O ports – Programming in C for PIC: Data types, I/O programming, logical operations, data conversion.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand the Microprocessor capability in general and explore the evaluation of microprocessors.
- understand the addressing modes of Microprocessors
- understand the Microcontroller capability
- program Microprocessors and Microcontrollers.
- interface Microprocessors and Microcontrollers with other electronic devices
- develop cyber physical systems

Text Books:

1. Ray and Burchandi, “Advanced Microprocessors and Interfacing”, Tata McGraw–Hill.
2. Kenneth J Ayala, “The 8051 Microcontroller Architecture, Programming and Applications”, Thomson Publishers, 2nd Edition.
3. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18, - Muhammad Ali Mazidi, RolindD.Mckinay , Danny causey -Pearson Publisher 21st Impression.

Reference Books:

1. Microprocessors and Interfacing, Douglas V Hall, Mc–Graw Hill, 2nd Edition.
2. R.S. Kaler, “ A Text book of Microprocessors and Micro Controllers”, I.K. International Publishing House Pvt. Ltd.
3. Ajay V. Deshmukh, “Microcontrollers – Theory and Applications”, Tata McGraw–Hill Companies –2005.
4. Ajit Pal, “Microcontrollers – Principles and Applications”, PHI Learning Pvt Ltd, 2011.

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COURSE STRUCTURE-R19

III Year – I SEMESTER		L	T	P	C
		0	0	3	1.5
ELECTRICAL MACHINES – II LABORATORY					

Learning objectives:

- To control the speed of three phase induction motors.
- To determine /predetermine the performance three phase and single phase induction motors.
- To improve the power factor of single phase induction motor .
- To predetermine the regulation of three–phase alternator by various methods, find X_d/ X_q ratio of alternator and asses the performance of three–phase synchronous motor.

Any 10 of the following experiments are to be conducted:

1. Brake test on three phase Induction Motor
2. No–load & Blocked rotor tests on three phase Induction motor
3. Regulation of a three –phase alternator by synchronous impedance &m.m.f. Methods
4. Regulation of three–phase alternator by Potier triangle method
5. V and Inverted V curves of a three—phase synchronous motor.
6. Determination of X_d and X_q of a salient pole synchronous machine
7. Equivalent circuit of single phase induction motor
8. Speed control of induction motor by V/f method.
9. Determination of efficiency of three-phase alternator by loading with three phase induction motor.
10. Power factor improvement of single-phase induction motor by using capacitors and load test on single-phase induction motor.
11. Parallel operation of three-phase alternator.
12. Brake test on single-phase AC series Motor.
13. Starting methods of a capacitor start and capacitor start run single-phase Induction motor.
14. Brake test on single-phase Induction Motor.

Learning outcomes:

After the completion of the course the student should be able to:

- assess the performance of single phase and three phase induction motors.
- control the speed of three phase induction motor.
- predetermine the regulation of three–phase alternator by various methods.
- find the X_d/ X_q ratio of alternator and asses the performance of three–phase synchronous motor.
- determine the performance single phase AC series motor.

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COURSE STRUCTURE-R19

III Year – I SEMESTER		L	T	P	C
		0	0	2	1
CONTROL SYSTEMS LABORATORY					

Learning Objectives:

- To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors and Synchros.
- To understand time and frequency responses of control system with and without controllers and compensators.

Any 10 of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Effect of P, PD, PI, PID Controller on a second order systems
4. Design of Lag and lead compensation – Magnitude and phase plot
5. Transfer function of DC motor
6. Bode Plot, Root locus, Nyquist Plots for the transfer functions of systems up to 5^{th} order using MATLAB.
7. Controllability and Observability Test using MAT LAB.
8. Temperature controller using PID
9. Characteristics of magnetic amplifiers
10. Characteristics of AC servo motor
11. Characteristics of DC servo motor
12. Block Diagram Representation of Field Controlled DC servo Motor Using Simulink.

Learning Outcomes:

After the completion of the course the student should be able to:

- analyze the performance and working Magnetic amplifier, D.C and A.C. servo motors and synchros.
- design P,PI,PD and PID controllers
- design lag, lead and lag–lead compensators
- control the temperature using PID controller
- determine the transfer function of D.C Motor
- control the performance of D.C and A.C Servo Motor.
- test the controllability and observability.
- judge the stability in time and frequency domain.

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III Year – I SEMESTER		L	T	P	C
		0	0	3	1.5
ELECTRICAL MEASUREMENTS & INSRUMENTATION LABORATORY					

Learning Objectives:

- To understand the correct function of electrical parameters and calibration of voltage, current, single phase and three phase power and energy, and measurement of electrical characteristics of resistance, inductance and capacitance of a circuits through appropriate methods.
- To understand the calibration of DC and AC Potentiometers.
- To understand the testing of CT and PT.
- To Understand and the characteristics of Thermo couples, LVDT, Capacitive transducer, piezoelectric transducer.
- To understand the measurement of strain, Phase difference and frequency.

Any 10 of the following experiments are to be conducted

1. Calibration of dynamometer wattmeter using phantom loading
2. Crompton D.C. Potentiometer - Calibration of PMMC ammeter and PMMC voltmeter
3. Kelvin's double Bridge - Measurement of resistance - Determination of tolerance.
4. Capacitance Measurement using Schering Bridge.
5. Inductance Measurement using Anderson Bridge.
6. Calibration of LPF Wattmeter – by direct loading.
7. Measurement of 3 phase power with single watt meter and 2 No's of C.T.
8. Testing of C.T. using mutual inductor – Measurement of % ratio error and phase angle of given C.T. by Null method.
9. P.T. testing by comparison – V.G as Null detector – Measurement of % ratio error and phase angle of the given P.T.
10. AC Potentiometer – Polar form/Cartesian form – Calibration of AC Voltmeter, Parameters of Choke
11. Thermocouple – characteristics
12. LVDT – characteristics.
13. Capacitive transducers characteristics.
14. Piezoelectric transducer characteristics.
15. Measurement of strain using strain gauge
16. Measurement of phase difference, frequency using Lissajous patterns in CRO.

Learning Outcomes:

After the completion of the course the student should be able to:

- measure the electrical parameters voltage, current, power, energy and electrical characteristics of resistance, inductance and capacitance.
- known the characteristics of transducers.
- measure the strains, frequency and phase difference.

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COURSE STRUCTURE-R19

III Year – I SEMESTER		L	T	P	C
		0	0	1	1
SOCIALLY RELAVENT PROJECTS					

Preamble:
There is lot of scientific and technological changes in the nation during last few decades in almost all the sectors. The state and central governments are introducing many schemes to all classes of people of the nation to increase the productivity in various sectors. India is a rural centric nation and the fruits of the scientific inventions and new technology shall be shared among all remote corners of the nation. With this aim, a socially relevant project is newly introduced in the curriculum with an objective of taking up the projects relevant to the societal needs.

Objectives:
(1) The student(s) shall explore the technological needs of society
(2) The student(s) shall understand the technological problems of society

General guidelines:

- A socially relevant project shall be a community service based project and it shall be innovative.
- A student has to pursue the socially relevant project to solve real life and pressing problems of society.
- The pursued socially relevant projects shall contribute to national development goals and priorities.
- Socially relevant project can be carried out by an individual student or by a team of maximum 5 of concerned department.
- The student(s) shall visit the society (Villages/Hospitals/Social Service Organizations etc) to identify the problem and conduct literature survey and provide a feasible solution.
- The socially relevant project selected shall be in the broad area of concerned discipline of course. Preference shall be given to rural societal problems.
- Each team shall work under the supervision of a faculty member of the concerned department.
- If the course is offered in II Year I Semester, the student or team of students shall complete this project during the vacation after I Year and so on.
- The duration of the project is about 15 to 20 hrs in total and students may split total duration into 2 to 3 hrs per day based convenience. The attendance shall be maintained by the supervisor.

Sample Projects (but not limited to):
(i) Energy Auditing in a rural village (ii) Smart starting and control of motors in agriculture and aqua fields (iii) TV Remote Operated Domestic Appliances Control (iv) Solar Powered Auto Irrigation System (v) Auto Intensity Control of Street Lights (vi) Hidden Active Cell Phone Detector (vii) Railway Track Security System (viii) Solar

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Power Charge Controller (ix) Home Automation System Using Digital Control (x) Intelligent Overhead Tank Water Level Indicator (xi) Pre Stampede Monitoring and Alarm System (xii) Detect Rash Driving Speed Checker System on Highways

Outcomes

(1) The student(s) are be able to provide a solutions the technological problems of society
(1) The student(s) is able suggest technological changes which suits current needs of society
(2) The student(s) are able to explain new technologies available for problems of the society.

Reference:

(1) Web Link: http://iitk.ac.in/new/socially-relevant-research
(2) https://csie.iitm.ac.in/SocialProjectsIITM.html
(3) http://www.iitkgp.ac.in/files/csr/csr_education.pdf

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRIC DRIVES					

Preamble:
This course is an extension of power electronics applications to electric drives. This course covers in detail the basic and advanced speed control techniques using power electronic converters that are used in industry. It is equally important to understand the four quadrant operation of electric drives and slip power recovery schemes in induction motors.

Learning Objectives:
- To learn the fundamentals of electric drive and different electric braking methods.
- To analyze the operation of three phase converter controlled dc motors and four quadrant operation of dc motors using dual converters.
- To discuss the converter control of dc motors in various quadrants.
- To understand the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
- To learn the principles of static rotor resistance control and various slip power recovery schemes.
- To understand the speed control mechanism of synchronous motors

UNIT–I:
Fundamentals of Electric Drives
Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

UNIT–II:
Controlled Converter Fed DC Motor Drives
1-phase half and fully controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics – Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.

UNIT–III:
DC–DC Converters Fed DC Motor Drives
Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation – Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics – Four quadrant operation – Closed loop operation (qualitative treatment only).

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UNIT–IV:
Stator side control of 3-phase Induction motor Drive
Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only).

UNIT–V:
Rotor side control of 3-phase Induction motor Drive & Synchronous Motor Drives
Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.

Separate control of synchronous motor – self control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive – PMSM (Basic operation only).

Learning Outcomes:
After the completion of the course the student should be able to:
- explain the fundamentals of electric drive and different electric braking methods.
- analyze the operation of three phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
- describe the converter control of dc motors in various quadrants of operation
- know the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
- differentiate the stator side control and rotor side control of three phase induction motor, explain the speed control mechanism of synchronous motors.

Text Books:
1. Fundamentals of Electric Drives – by G K Dubey, Narosa Publications
2. Power Semiconductor Drives, by S.B.Dewan, G.R.Slemon, A.Straughen, Wiley-India Edition.

Reference Books:
1. Electric Motors and Drives Fundamentals, Types and Apllications, by Austin Hughes and Bill Drury, Newnes.
2. Thyristor Control of Electric drives – VedamSubramanyam Tata McGraw Hill Publications.
3. Power Electronic Circuits, Devices and applications by M.H.Rashid, PHI
4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.

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COURSE STRUCTURE-R19

III Year – II SEMESTER		L	T	P	C
		3	0	0	3

POWER SYSTEM ANALYSIS

Preamble:
The course is designed to give students the required knowledge for the design and analysis of electrical power grids. Calculation of power flow in a power system network using various techniques, formation of Z_{bus} and its importance are covered in this course. It also deals with short circuit analysis and analysis of power system for steady state and transient stability.

Learning Objectives:
- To development the impedance diagram (p.u) and formation of Y_{bus}
- To study the different load flow methods.
- To study the concept of the Z_{bus}building algorithm.
- To study short circuit calculation for symmetrical faults
- To study the effect of unsymmetrical faults and their effects.
- To study the rotor angle stability of power systems.

UNIT –I:
Circuit Topology & Per Unit Representation
Graph theory definition – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y_{bus} matrix by singular transformation and direct inspection methods - Per Unit Quantities–Single line diagram– Impedance diagram of a power system.

UNIT –II:
Power Flow Studies
Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) –Decoupled and Fast Decoupled methods – Algorithmic approach –Problems on 3–bus system only.

UNIT – III:
Z-Bus Algorith & Symmetrical Fault Analysis:
Formation of Z_{bus}**:** Algorithm for the Modification of Z_{bus} Matrix (without mutual impedance).

Symmetrical Fault Analysis:
Reactances of Synchronous Machine – Three Phase Short Circuit Currents - Short circuit MVA calculations for Power Systems.

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UNIT –IV:
Symmetrical Components & Fault analysis
Definition of symmetrical components - symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence impedances: Synchronous generator – Transmission line and transformers – Sequence networks –Various types of faults LG– LL– LLG and LLL on unloaded alternator–unsymmetrical faults on power system for numerical problems only.

UNIT – V:
Power System Stability Analysis
Elementary concepts of Steady state – Dynamic and Transient Stabilities – Description of Steady State Stability Power Limit –Transfer Reactance–Synchronizing Power Coefficient – Power Angle Curve and Determination of Steady State Stability – Derivation of Swing Equation–Determination of Transient Stability by Equal Area Criterion –Applications of Equal Area Criterion – Methods to improve steady state and transient stability.

`Learning Outcomes:
After the completion of the course the student should be able to:

- draw impedance diagram for a power system network and to understand per unit quantities.
- form a Y_{bus} and Z_{bus} for a power system networks.
- understand the load flow solution of a power system using different methods.
- find the fault currents for all types faults to provide data for the design of protective devices.
- find the sequence components of currents for unbalanced power system network.
- analyze the steady state, transient and dynamic stability concepts of a power system.

Text Books:

1. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
2. Modern Power system Analysis – by I.J.Nagrath & D .P.Kothari: Tata McGraw–Hill Publishing Company, 2nd edition.

Reference Books:

1. Power System Analysis – by A.R.Bergen, Prentice Hall, Inc.
2. Power System Analysis by HadiSaadat – TMH Edition.
3. Power System Analysis by B.R.Gupta, Wheeler Publications.
4. Power System Analysis and Design by J.Duncan Glover, M.S.Sarma, T.J.Overbye – Cengage Learning publications.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3

DATA STRUCTURES

Preamble:
This course is core subject developed to help the student understand the data structure principles used in power systems, machines and control systems. This subject covers linear data structures, linked lists, trees, graphs, searching and sorting.

Course Objectives:

- Operations on linear data structures and their applications.
- The various operations on linked lists.
- The basic concepts of Trees, Traversal methods and operations.
- Concepts of implementing graphs and its relevant algorithms.
- Sorting and searching algorithms.

Unit-1:
Linear Data Structures: Arrays, Stacks And Queues
Data Structures -Operations-Abstract Data Types-Complexity of Algorithms-Time and Space-Arrays-Representation of Arrays-Linear Arrays-Insertion–Deletion and Traversal of a Linear Array-Array as an Abstract Data Type-Multi-Dimensional arrays-Strings-String Operations-Storing Strings-String as an Abstract Data Type

Stack -Array Representation of Stack-Stack Abstract Data Type-Applications of Stacks: Prefix-Infix and Postfix Arithmetic Expressions-Conversion-Evaluation of Postfix Expressions-Recursion-Towers of Hanoi-Queues-Definition-Array Representation of Queue-The Queue Abstract Data Type-Circular Queues-Dequeues-Priority Queues.

Unit-II:
Linked Lists
Pointers-Pointer Arrays-Linked Lists-Node Representation-Single Linked List-Traversing and Searching a Single Linked List-Insertion into and Deletion from a Single Linked List-Header Linked Lists-Circularly Linked Lists-Doubly Linked Lists-Linked Stacks and Queues-Polynomials-Polynomial Representation-Sparse Matrices.

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Unit-III:

Trees

Terminology-Representation of Trees-Binary Trees-Properties of Binary Trees-Binary Tree Representations-Binary Tree Traversal-Preorder-Inorder and Postorder Traversal-Threads-Thread Binary Trees-Balanced Binary Trees-Heaps-Max Heap-Insertion into and Deletion from a Max Heap-Binary Search Trees-Searching-Insertion and Deletion from a Binary Search Tree-Height of Binary Search Tree, m-way Search Trees, B-Trees.

Unit-IV:

Graphs

Graph Theory Terminology-Graph Representation-Graph Operations-Depth First Search-Breadth First Search-Connected Components-Spanning Trees-Biconnected Components-Minimum Cost Spanning Trees-Kruskal's Algorithm-Prism's Algorithm-Shortest Paths-Transitive Closure-All-Pairs Shortest Path-Warshall's Algorithm.

Unit-V:

Searching And Sorting

Searching -Linear Search-Binary Search-Fibonacci Search-Hashing-Sorting-Definition-Bubble Sort-Insertion sort-Selection Sort-Quick Sort-Merging-Merge Sort-Iterative and Recursive Merge Sort-Shell Sort-Radix Sort-Heap Sort.

Course Outcomes:

After the completion of the course the student should be able to:

- data structures concepts with arrays, stacks, queues.
- linked lists for stacks, queues and for other applications.
- traversal methods in the Trees.
- various algorithms available for the graphs.
- sorting and searching in the data ret retrival applications.

Text Books:

1. Fundamentals of Data Structures in C, 2nd Edition, E.Horowitz, S.Sahni and Susan Anderson Freed, Universities Press Pvt. Ltd.
2. Data Structures With C, Seymour Lipschutz, Schaum's Outlines, Tata McGraw Hill.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
DIGITAL CONTROL SYSTEMS					

Preamble:
In recent years digital controllers have become popular due to their capability of accurately performing complex computations at high speeds and versatility in leading nonlinear control systems. In this context, this course focuses on the analysis and design of digital control systems.

Learning objectives:
- To understand the concepts of digital control systems and assemble various components associated with it. Advantages compared to the analog type.
- The theory of z–transformations and application for the mathematical analysis of digital control systems.
- To represent the discrete–time systems in state–space model and evaluation of state transition matrix, the design of state feedback control by "the pole placement method.", design of state observers.
- To examine the stability of the system using different tests.
- To study the conventional method of analyzing digital control systems in the w–plane.

UNIT – I:
Introduction and signal processing
Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Continuous and Discrete Time Signals – Sample and hold devices – Sampling theorem and data reconstruction – Frequency domain characteristics of zero order hold.

UNIT–II:
z–transformations
z–Transforms – Theorems – Finding inverse z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses.

UNIT–III:
State space analysis and the concepts of Controllability and observability
State space representation of discrete time systems – Solving Discrete Time state space equations – State transition matrix and its properties – Discretization of continuous time state equations – Concepts of controllability and observability – Tests(without proof).

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State Feedback Controllers and State Observers
Design of state feedback controller through pole placement – Necessary and sufficient conditions – Ackerman's formula – Design of state observers (Full Order and Reduced Order).

UNIT – IV:
Stability analysis
Mapping between the s–Plane and the z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test.

UNIT – V:
Design of discrete–time control systems by conventional methods
Transient and steady state specifications – Design using frequency response in the w–plane for lag and lead compensators – Root locus technique in the z–plane.

Learning outcomes:
After the completion of the course the student should be able to:

- learn the advantages of discrete time control systems and the "know how" of various associated accessories.
- understand z–transformations and their role in the mathematical analysis of different systems(like Laplace transforms in analog systems).
- learn the stability criterion for digital systems and methods adopted for testing the same are explained.
- understand the conventional and state space methods of design are also introduced.

Text Book:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal, TMH, 4th Edition.

Reference Books:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
DIGITAL IC APPLICATIONS (ELECTIVE-I)					

Preamble:

This course introduces digital logic families and interfacing concepts for digital design and introduces VHDL fundamentals to model digital system design blocks. Behavioral modeling of digital circuits is discussed. Design and implementation of combinational, synchronous and asynchronous sequential digital logic circuits are introduced.

Learning Objectives:

- Introduction of digital logic families and interfacing concepts for digital design is considered.
- VHDL fundamentals were discussed to modeling the digital system design blocks.
- VHDL compilers, simulators and synthesis tools are described, which are used to verify digital systems in a technology-independent fashion.
- Design and implementation of combinational and sequential digital logic circuits is explained.

UNIT-I:

Digital Logic Families, Interfacing and Introduction to VHDL

Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behavior, CMOS logic families. Bipolar logic, transistor-transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic.

Design flow, program structure, levels of abstraction, Elements of VHDL: Data types, data objects, operators and identifiers. Packages, Libraries and Bindings, Subprograms. VHDL Programming using structural and data flow modeling.

UNIT-II:

Behavioral Modeling

Process statement, variable assignment statement, signal assignment statement, wait statement , if statement, case statement ,null statement, loop statement, exit statement, next statement ,assertion statement, more on signal assignment statement ,Inertial Delay Model, Transport Delay Model ,Creating Signal Waveforms, Signal Drivers , Other Sequential Statements , Multiple Processes. Logic Synthesis, Inside a logic Synthesizer.

UNIT-III:

Combinational Logic Design

Binary Adder-Subtractor, Ripple Adder, Look Ahead Carry Generator, ALU, Decoders, encoders, multiplexers and demultiplexers, parity circuits, comparators, Barrel Shifter, Simple

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Floating-Point Encoder, Dual Priority Encoder, Design considerations of the above combinational logic circuits with relevant Digital ICs, modeling of above ICs using VHDL.

UNIT-IV
Sequential Logic Design
SSI Latches and flip flops, Ring Counter, Johnson Counter, Design of Modulus N Synchronous Counters, Shift Registers, Universal Shift Registers, Design considerations of the above sequential logic circuits with relevant Digital ICs, modeling of above ICs using VHDL**.**

UNIT-V:
Synchronous and Asynchronous Sequential Circuits
Basic design steps: State diagram, state table, state assignment, choice of flip flops and derivation of next state and output expressions, timing diagram. State assignment problem: One hot encoding. Mealy and Moore type FSM for serial adder, VHDL code for the serial adder. Analysis of Asynchronous circuits, State Reduction, State Assignment. A complete design example: The vending machine controller.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand the structure of commercially available digital integrated circuit families.
- learn the IEEE Standard 1076 Hardware Description Language (VHDL).
- model complex digital systems at several levels of abstractions, behavioral, structural, simulation, synthesis and rapid system prototyping.
- analyze and design basic digital circuits with combinatorial and sequential logic circuits using VHDL.

Text Books:

1. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 3rd Ed., 2005.
2. VHDL Primer – J. Bhasker, Pearson Education/ PHI, 3rd Edition.

References:

1. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, ZvonkoVranesic, McGrawHill, 3rd Edition.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
COMMUNICATION SYSTEMS					

Preamble:
Awareness on the concepts and working of communication blocks is inevitable for an electrical engineering student to excel in smart grid applications.
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Learning Objectives:

- To develop a fundamental understanding on communication systems with emphasis on analog and digital modulation techniques.
- To get introduced to the basics of error control coding techniques.

Unit – I:
Basic blocks of Communication System. Analog Modulation - Principles of Amplitude Modulation, DSBSC, SSB-SC and VSB-SC, AM transmitters and receivers.

Unit- II:
Angle Modulation - Frequency and Phase Modulation. Transmission Bandwidth of FM signals, Methods of generation and detection, FM Transmitters and Receivers.

Unit–III:
Sampling theorem - Pulse Modulation Techniques - PAM, PWM and PPM concepts - PCM system – Data transmission using analog carriers (BASK, BFSK, BPSK, QPSK).

UNIT IV:
Error control coding techniques – Linear block codes- Encoder and decoder, Cyclic codes – Encoder, Syndrome Calculator, Convolution codes.

UNIT V:
Modern Communication Systems – Microwave communication systems - Optical communication system - Satellite communication system - Mobile communication system.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand the basics of communication system, analog and digital modulation techniques.

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- apply the knowledge of digital electronics and understand the error control coding techniques.
- summarize different types of communication systems and its requirements.

Text Books:

1. Simon Haykins, 'Communication Systems', John Wiley, 3rd Edition, 1995.
2. D.Roddy & J.Coolen, 'Electronic Communications', Prentice Hall of India, 4th Edition, 1999.
3. Kennedy G, 'Electronic Communication System', McGraw Hill, 1987.

Reference Books:

1. Shulin Daniel, 'Error Control Coding', Pearson, 2nd Edition, 2011.
2. B.P. Lathi and Zhi Ding, 'Modern Digital and Analog Communication Systems', OUP USA Publications, 4th Edition, 2009.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
COMPUTER NETWORKS (ELECTIVE-I)					

Preamble:
This course is designed to impart the knowledge in computer networks used for data transmission through internet. The topics covered in this subject are LAN, WAN, TCP/ICP models, Digital modulation and multiplexing, Layers of computer networks, Protocol, Routing algorithms, etc.

Learning Objectives:

- Understand state-of-the-art in network protocols, architectures, and applications.
- Process of networking research
- Constraints and thought processes for networking research
- Problem Formulation—Approach—Analysis—

UNIT – I:
INTRODUCTION COMPUTER NETWORKS:
Network Topologies WAN, LAN, MAN. Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models

Physical Layer – Fourier Analysis – Bandwidth Limited Signals – The Maximum Data Rate of a Channel - Guided Transmission Media, Digital Modulation and Multiplexing: Frequency Division Multiplexing, Time Division Multiplexing, Code Division Multiplexing
Data Link Layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols, Sliding Window Protocols

UNIT – II:
THE DATA LINK LAYER: Services Provided to the Network Layer – Framing – Error Control – Flow Control, Error Detection and Correction – Error-Correcting Codes – Error Detecting Codes, Elementary Data Link Protocols- A Utopian Simplex Protocol-A Simplex Stop and Wait Protocol for an Error free channel-A Simplex Stop and Wait Protocol for a Noisy Channel, Sliding Window Protocols-A One Bit Sliding Window Protocol-A Protocol Using Go-Back-N- A Protocol Using Selective Repeat

UNIT – III:
MEDIUM ACCESS CONTROL SUBLAYER-The Channel Allocation Problem-Static Channel Allocation-Assumptions for Dynamic Channel Allocation, Multiple Access Protocols-

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Aloha-Carrier Sense Multiple Access Protocols-Collision-Free Protocols-Limited Contention Protocols-Wireless LAN Protocols, Ethernet-Classic Ethernet Physical Layer-Classic Ethernet MAC Sublayer Protocol-Ethernet Performance-Fast Ethernet Gigabit Ethernet-10-Gigabit Ethernet-Retrospective on Ethernet, Wireless Lans-The 802.11 Architecture and Protocol Stack-The 802.11 Physical Layer-The802.11 MAC Sublayer Protocol-The 805.11 Frame Structure-Services

UNIT – IV:
DESIGN ISSUES-The Network Layer Design Issues – Store and Forward Packet Switching-Services Provided to the Transport layer- Implementation of Connectionless Service-Implementation of Connection Oriented Service-Comparison of Virtual Circuit and Datagram Networks, Routing Algorithms-The Optimality principle-Shortest path Algorithm, Congestion Control Algorithms-Approaches to Congestion Control-Traffic Aware Routing-Admission Control-Traffic Throttling-Load Shedding.

UNIT – V:
TRANSPORT LAYER: The Internet Transport Protocols: Udp, the Internet Transport Protocols: TCP Application Layer –The Domain Name System: The DNS Name Space, Resource Records, Name Servers, Electronic Mail: Architecture and Services, The User Agent, Message Formats, Message Transfer, Final Delivery

Learning Outcomes:
After the completion of the course the student should be able to:

- understand OSI and TCP/IP models
- analyze MAC layer protocols and LAN technologies
- design applications using internet protocols
- understand routing and congestion control algorithms
- understand how internet works

Text Books:

1. Tanenbaum and David J Wetherall, Computer Networks, 5th Edition, Pearson Edu, 2010
2. Computer Networks: A Top Down Approach, Behrouz A. Forouzan, FirouzMosharraf, McGraw Hill Education

Reference Books:

1. Larry L. Peterson and Bruce S. Davie, “Computer Networks - A Systems Approach” (5th ed), Morgan Kaufmann/ Elsevier, 2011

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
INTERNET OF THINGS APPLICATIONS TO ELECTRICAL ENGINEERING (ELECTIVE-I)					

Preamble:
Importance to the development of miniature devices for monitoring and sensing of data using internet is increasing day by day. In view of this, to give an insight about these technologies to the students of electrical engineering this course in designed. In this course, introduction to Internet of Things, various architectures of IoT, Communication protocols are introduced. In addition, data acquisition, data communication, introduction to data analytics, sensors and actuators are also presented. To give a view about the IoT implementations, few case studies about Smart Home, Smart Cities, Environment monitoring and smart agriculture practices are also presented.

Learning Objectives:
- To understand fundamentals, architecture and various technologies of Internet of Things.
- To know various communication technologies used in the Internet of Things.
- To know the connectivity of devices using web and internet in the IoT environment.
- To know various data acquisition methods, data handling using cloud for IoT applications.
- To understand the implementation of IoT by studying case studies like Smart Home, Smart city, etc.

UNIT - I:
The Internet of Things: An Overview of Internet of Things (IoT) – IoT framework – Architecture – Technology behind IoT – Sources of the IoT – M2M Communication – Examples ofIoT.

UNIT – II:
Design Principles For Connected Devices: Introduction –IoT/M2M systems, Layers and Designs Standardization – Communication Technologies – Data Enrichment, Consolidation and Device Management at Gateway – Ease of designing and affordability.

UNIT – III:
Design Principles for the Web Connectivity: Introduction – Web Communication protocols for Connected Devices - Message Communication protocols for Connected Devices – Web Connectivity for connected devices network.

COURSE STRUCTURE-R19

Introduction to Internet Connectivity Principles, Internet connectivity, Internet based communication – IP addressing in the IoT – Application Layer Protocols: HTTP, HTTPS, FTP, Telnet, WAP (Wireless Application Protocol).

UNIT–IV:

Data Acquiring, Organizing, Processing and Analytics: Introduction – Data Acquiring and Storage – Organizing the Data – Analytics.

Data Collection, Storage and Computing Using a Cloud Platform: Introduction – Cloud computing paradigm for data collection, storage and computing – IoTas a service and Cloud Service Models - IoT cloudbased services using the Xively (Pachube/COSM), Nimbits and other platforms.

UNIT– V:

Sensor technology: Actuator, Sensor data communication protocols, Radio Frequency Identification technology, Wireless Sensor Network Technology.

IoT application case studies: Smart Home, Smart Cities, Environment monitoring and Agriculture practices.

Learning Outcomes:

After the completion of the course the student should be able to:

- know the various fundamentals, architectures and technologies of Internet of Things.
- understand various communication technologies used in the Internet of Things.
- understand the various device connectivity methods using web and internet in the IoT environment.
- understand various data acquisition methods, data handling using cloud for IoT applications.
- know the implementation of IoT from the case studies like Smart Home, Smart city, etc.

Text Books:

1. Internet of Things: Architecture, Design Principles, Raj Kamal, McGraw Hill Education (India) Pvt. Limited, 2017.

Reference Books:

1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley, First edition, 2013.
2. Getting Started with the Internet of Things, CunoPfister, O'reilly, 2011.
3. Internet of Things : A Hands-on Approach, ArshdeepBahga, and Vijay Madisetti, 2014.

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		3	0	0	3
VLSI DESIGN (ELECTIVE-I)					

Preamble:
This is an elective course designed to impart the knowledge in VLSI design principles. This course covers MOS devices and fabrication, CMOS logic circuits and applications of logic circuits.

Learning Objective:

- MOS and CMOS circuits features and characteristics.
- Fabrication principles of CMOS.
- Implementation of CMOS logic circuits.
- Memory design with CMOS family.
- Applications of CMOS circuits.

UNIT – I:
Introduction to MOS Devices
MOS characteristics: NMOS characteristics, inverter action – CMOS characteristics, inverter action - models and second order effects of MOS transistors – Current equation – MOSFET Capacitances - MOS as Switch, Diode/ resistor – current source and sink – Current mirror.

UNIT – II:
MOS Fabrication
CMOS Fabrication – n-well, p-well, twin-tub processes – fabrication steps – crystal growth – photolithography – oxidation – diffusion – Ion implantation – etching – metallization.

UNIT – III:
CMOS Logic Circuits
CMOS Logic Circuits: Implementation of logic circuits using nMOS and CMOS, Pass transistor and transmission gates – Implementation of combinational circuits – parity generator – magnitude comparator – stick diagram – Design rules and layout design.

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UNIT – IV:

Higher order digital Logic Circuits

Memory design – SRAM cell – 6T SRAM – DRAM – 1T, 3T, 4T cells, CMOS Sequential circuits: Static and Dynamic circuits – True Single-phase clocked registers – Clocking schemes.

UNIT – V:

Application Specific Integrated Circuits

ASIC - Types of ASICs - Design flow – Design Entry – Simulation – Synthesis – Floor planning – Placement – Routing - Circuit extraction – Programmable ASICs.

Learning Outcomes:

After the completion of the course the student should be able to:

- understand the insights of the MOS devices and its characteristics.
- appreciate the different VLSI process technologies.
- design the CMOS combinational logic circuits and its layout.
- develop the sequential circuits and clocking schemes.
- realize the Design flow of application-specific Integrated circuit.

Text Books:

1. Neil Weste, David Harris, ‘CMOS VLSI Design: A Circuits and Systems Perspective’, AddisonWesley, 4th Edition, 2020.
2. Debaprasad Das, ‘VLSI Design’, Oxford University Press, 2010.
3. Ken Martin, ‘Digital Integrated Circuits’, Oxford University Press, 1999.
4. Peter Van, ‘Microchip Fabrication’, Mc-Graw Hill Professional, 6th Edition, 2014.

Reference Books:

1. M. J. S. Smith, ‘Application Specific Integrated Circuits’, Addison Wesley, 1997.
2. Uyemura, ‘Introduction to VLSI Circuits and Systems’, Wiley, 1st Edition, 2012.

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		3	0	0	3
CLOUD COMPUTING (ELECTIVE-I)					

Preamble:
This is an elective subject designed to known principles of clod computing. Inthis subject systems modeling, clustering, visualization, virtual machines, Data centres, Cloud architecture, cloud programming, resource management and scheduling and storage will be explained.

Learning Objectives:

- The cloud environment, building software systems.
- Components that scale to millions of users in modern internetcloud concepts capabilities across the various cloud service models including Iaas, Paas, Saas,
- Developing cloud based software applications on top of cloud platforms.

UNIT -I:
Systems modeling, Clustering and virtualization
Scalable Computing over the Internet, Technologies for Network based systems, System models for Distributed and Cloud Computing, Software environments for distributed systems and clouds, Performance, Security And Energy Efficiency

UNIT- II:
Virtual Machines and Virtualization of Clusters and Data Centers
Implementation Levels of Virtualization, Virtualization Structures/ Tools and mechanisms, Virtualization of CPU, Memory and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data Center Automation.

UNIT- III:
Cloud Platform Architecture
Cloud Computing and service Models, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms, Inter Cloud Resource Management, Cloud Security and Trust Management. Service Oriented Architecture, Message Oriented Middleware.

Cloud Programming and Software Environments
Features of Cloud and Grid Platforms, Parallel & Distributed Programming Paradigms, Programming Support of Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud Software Environments.

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UNIT-IV:

Cloud Resource Management and Scheduling

Policies and Mechanisms for Resource Management Applications of Control Theory to Task Scheduling on a Cloud, Stability of a Two Level Resource Allocation Architecture, Feedback Control Based on Dynamic Thresholds. Coordination of Specialized Autonomic Performance Managers, Resource Bundling, Scheduling Algorithms for Computing Clouds, Fair Queuing, Start Time Fair Queuing, Borrowed Virtual Time, Cloud Scheduling Subject to Deadlines, Scheduling MapReduce Applications Subject to Deadlines.

UNIT- V:

Storage Systems

Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Apache Hadoop, Big Table, Megastore, Amazon Simple Storage Service (S3)

Learning Outcomes:

After the completion of the course the student should be able to:

- understanding the key dimensions of the challenge of Cloud Computing
- assessment of the economics , financial, and technological implications for selecting cloud computing for own organization
- assessing the financial, technological, and organizational capacity of employer's for actively initiating and installing cloud-based applications.
- assessment of own organizations' needs for capacity building and training in cloud computing-related IT areas

Text Books:

1. Distributed and Cloud Computing, Kai Hwang, Geoffry C. Fox, Jack J. Dongarra MK Elsevier.
2. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier.
3. Cloud Computing, A Hands on approach, ArshadeepBahga, Vijay Madisetti, University Press

Reference Books:

1. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH
2. Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, TMH

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		3	0	0	3

RENEWABLE ENERGY SOURCES
(OPEN ELECTIVE-I)

Preamble:
This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, biomass, fuel cells and geothermal systems.

Learning Objectives:
- To study the solar radiation data, extraterrestrial radiation, radiation on earth's surface.
- To study solar photo voltaic systems.
- To study maximum power point techniques in solar pv and wind energy.
- To study wind energy conversion systems, Betz coefficient, tip speed ratio.
- To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

UNIT–I:
Fundamentals of Energy Systems and Solar energy
Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation**:** Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry – Radiation on tilted surfaces – Numerical problems.

UNIT–II:
Solar Photovoltaic Systems
Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems – Balance of system components - System design**:** storage sizing – PV system sizing – Maximum power point tracking.

UNIT–III:
Wind Energy
Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency – Power output of wind turbine – Selection of generator(synchronous, induction) – Maximum power point tracking – wind farms – Power generation for utility grids.

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UNIT–IV:
Hydro and Tidal power systems
Basic working principle – Classification of hydro systems**:** Large, small, micro – measurement of head and flow – Energy equation – Types of turbines – Numerical problems.
Tidal power – Basics – Kinetic energy equation – Turbines for tidal power - Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

UNIT–V:
Biomass, fuel cells and geothermal systems
Biomass Energy**:** Fuel classification – Pyrolysis – Direct combustion of heat – Different digesters and sizing.
Fuel cell**:** Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics.
Geothermal**:** Classification – Dry rock and hot acquifer – Energy analysis – Geothermal based electric power generation

Learning Outcomes:
After the completion of the course the student should be able to:

- analyze solar radiation data, extraterrestrial radiation, and radiation on earth's surface.
- design solar photo voltaic systems.
- develop maximum power point techniques in solar PV and wind energy systems.
- explain wind energy conversion systems, wind generators, power generation.
- explain basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

Text Books:

1. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition,2013.
2. Non Conventional sources of Energy by G.D.Rai, Kanna Publications.

Reference Books:

1. Energy Science**:** Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press.
2. Solar Energy**:** Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
3. Renewable Energy- Edited by Godfrey Boyle-oxford university.press,3rd edition,2013.
4. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
5. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
6. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
7. Non conventional energy source –B.H.khan- TMH-2nd edition.

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		3	0	0	3

ESSENTIALS OF ANALOG AND DIGITAL ELECTRONICS
(OPEN ELECTIVE-I)

Preamble:
This is an open elective course designed to give the basic knowledge od analog and digital electronics to core engineering students. This course covers analog devices, digital components, signal generator circuits, decoders, programmable logic devices LCD, LED displays, Analog to Digital & Digital to Analog converters.

Learning Objectives:
- To understand the concepts of analog and digital devices & circuits.
- To understand signal generation circuits.
- To understand the digital & analog quantities and conversion from one to the other.
- To design and control LCD and LED displays.

UNIT -I
Review of Analog devices- Diode – P-N Diode- Zener Diode – V-I Characteristics - Rectifier Circuits –Wave Shaping Circuits – Clippers and Clampers – Zener regulator Circuits.
Op-amp –Inverting & non-inverting - Operation – Differentiator, integrator, precision rectifier, square waveform for generator, passive components – TTL, CMOS devices.

UNIT II
Oscillators & Signal generator circuits – Function generator circuit – Pulse generator circuit – AM/FM signal generator circuit – Qualitative analysis.

UNIT –III
Review of Digital components – Code converters: Binary to Gray Code – BCD to Seven segment decoder –Programmable Logic Devices: PROM, PAL, PLA. Sequential Logic: Latch & Flip flop, MOD- Counters – Shift Registers - Asynchronous 3-Bit Counter
.

UNIT -IV
Display Units – Optoelectronic devices –Seven segment displays – LCD and LED display units and applications –I^2C, SIP Protocol.

UNIT -V
Special electronic circuits- Schmitt trigger – Analog to Digital converter – Digital to Analog converter units.

Learning Outcomes:
After the completion of the course the student should be able to:

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- design and develop circuits using analog and digital components.
- understand the different generators and analyzers.
- appreciate the use of display units.
- design Analog to Digital and Digital to Analog Converters.

Text Books:

1. David A Bell, 'Fundamentals of Electronic Devices and Circuits', Oxford University Press, Incorporated, Recent Edition.
2. Kalsi H.S,'Electronic Instrumentaion', Tata McGraw-Hill Education, 3rd Edition, 2010.
3. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, Recent version..

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
ELECTRICAL ESTIMATION AND COSTING (OPEN ELECTIVE-I)					

Preamble:
This course covers the topics on simple electrical connections design considerations of electrical installations and study of different types of electrical installations. It also covers the components of substations and various motor control circuits.

Learning Objectives:

- Introduce the electrical symbols and simple electrical circuits
- Able to learn the design of electrical installations.
- Able to learn the design of electrical installation for different types of buildings and small industries.
- Learn the basic components of electrical substations.
- Familiarize with the motor control circuits

UNIT -I:
Electrical Symbols and Simple Electrical Circuits
Need of electrical symbols, list of symbols, Electrical Diagrams, Methods of representation for wiring diagrams, introduction to simple light and fan circuits, system of connection of appliances and accessories, simple examples on light and fan circuits.

Unit-II:
Design Considerations of Electrical Installations
Electric supply system, Three-phase four wire distribution system, protection of electric installation against overload, short circuit and earth fault, earthing, neutral and earth wire, types of loads, systems of wiring, permissible of voltage drops and sizes of wires , estimating and costing of electrical installations

Unit-III:
Electrical Installation for Different Types of Buildings and Small Industries
Electrical installations for electrical buildings, estimating and costing of material, simple examples on electrical installation for residential buildings, electrical installations for commercial buildings, electrical installation for small industries

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Unit-IV:
Substations
Introduction, types of substations, outdoor substations-pole mounted type, indoor substations-floor mounted type, simple examples on quantity estimation.

Unit-V: Motor control circuits
Introduction to AC motors, starting of three phase squirrel cage induction motors, starting of wound rotor motors, starting of synchronous motors, contractor control circuit components, basic control circuits, motor protection

Learning Outcomes:
After the completion of the course the student should be able to:

- identify the various electrical apparatus and their interconnections.
- select suitable electrical supply system and design earthing systems of various electric loads.
- estimate the cost for installation of wiring for different types of building and small industries.
- identify the components of electrical substations.
- design suitable control circuit for starting of three phase induction motor and synchronous motor.

Text Books:

1. Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers.

References Books:

1. Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers, sixth edition, 1987.
2. A course in electrical installation estimating and costing – J.B.Gupta –Kataria SK & Sons.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
POWER ELECTRONICS DEVICES & CIRCUITS (Open Elective-I)					

Preamble

The course is intended to make the difference between signal and power semiconductor devices in their physical operation and characteristics.

Learning Objectives:

- To understand the physics of basic semiconductor devices and power diode.
- To study the physics and operating characteristics of BJT and power MOSFET.
- To understand the operation and characteristics of thyristor and GTOs.
- To understand the physics and characteristics of IGBT.
- To study the operation of emerging devices and their integrated circuits.

UNIT -I:

Basic Semiconductor Physics & Power Diodes

Basic Semiconductor Physics: Introduction - Conduction Process in Semiconductors - pn junction - Avalanche Breakdown -

Power Diodes: Introduction - Basic Structures and I-V Characteristics - Breakdown Voltage Considerations - Switching Characteristics.

UNIT -II:

Bipolar Junction Transistors & Power MOSFET

Bipolar Junction Transistors: Introduction - Vertical Power Transistor Structures - Characteristics - Physics of BJT Operation - Switching Characteristics - Breakdown Voltages - Second Breakdown - On-State Losses - Safe Operating Areas.

Power MOSFET: Introduction – Basic Structure - I-V Characteristics - Physics of Device Operation - Switching Characteristics - Operating Limitations and Safe Operating Areas.

UNIT -III:

Thyristors & GTO

Thyristors: Introduction - Basic Structure – I-V Characteristics – Physics of Device Operation – Switching Characteristics - Methods of Improving di/dt and dv/dt Ratings

GTO: Introduction - Basic Structure – I-V Characteristics - Physics of Turn-off Operation – Switching Characteristics.

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UNIT -IV:
Insulated Gate Bipolar Transistors
Introduction – Basic structure – I-VCharacteristics – Physics of Devices Operation – Latchup in IGBTs – Switching Characteristics.

UNIT -V:
Emerging Devices and Circuits
Introduction – Power Junction Field Effect Transistors – Field-controlled Thyristor – JFET – Based Devices versus Other Power Devices – MOS-controlled Thyristor – Power Integrated Circuits.

Learning Outcomes:
After the completion of the course the student should be able to:

- explain the basics of semiconductor devices and use of Power diode.
- know the operation and characteristics of BJT and power MOSFETs.
- explain the basic difference of thyristors and GTOs in their physics and characteristics.
- know the operation of IGBT, emerging devices and circuits.

Text Books:

1. Power Electronics: converters, applications & design -by Nedmohan, Tore M. Undeland, Robbins by Wiley India Pvt. Ltd.
2. Power Electronics: Circuits, Devices and Applications – by M. H. Rashid, Prentice Hall of India, 2nd edition, 1998.
3. Power Electronics – by P.S.Bhimbra, Khanna Publishers.

Reference Books:

1. Elements of Power Electronics–Philip T.Krein. oxford.
2. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.
5. Power Converter Circuits -by William Shepherd, Li zhang, CRC Taylor & Francis Group.

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III Year – II SEMESTER		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF ELECTRICAL MACHINES (OPEN ELECTIVE-I)					

Preamble:

This course introduces the fundamentals of basic electrical circuits and topics related to principles, performance, applications and design considerations of dc machines and transformers. The course also covers the topics of different types of 3-phase induction motors and synchronous machines synchronous machines and their applications.

Learning Objectives:

- Understand the fundamentals in electrical machines.
- Know the characteristics of DC machines.
- Understand the operation and performance of Transformer.
- Understand the operation and starting methods of Induction motors.
- Understand the operation and application of Synchronous machine.

UNIT -I:

Introduction

Active and passive elements- Ohm's Law – Kirchhoff's Laws –Electromagnetic Induction– Faraday's Laws - Series – Parallel circuits- Self and Mutual Inductance-Numerical problems. Purpose of Earthing – Methods of Earthing – Merits of Earthing. Different types of Electrical Machines.

UNIT -II:

DC Machines

Principle of operation of DC generator - Types of DC machines – EMF equation –- Open Circuit Characteristics- Principle of operation of DC Motor- Torque Equation- speed control methods of DC motor – Losses in DC machines - Swinburne's Test-Brake test on DC shunt motor – Performance Characteristics - Numerical problems.

UNIT -III:

Transformers

Principle of operation and construction Details – Classification of Transformers - EMF equation – Losses in a Transformer – Open Circuit & Short Circuit Test – Calculation of efficiency and regulation -Numerical Problems.

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UNIT -IV:
Induction Motors
Principle of operation- Constructional Details - Classification – Revolving Magnetic Fields– Starting Methods – Numerical Problems. Principle of operation of Single Phase Induction Motor - Starting Methods- Applications.

UNIT -V:
Synchronous Machines
Principle of operation and construction of alternators –EMF Equation - Regulation of alternator by Synchronous Impedance Method – Numerical Problems.
Principle of operation of synchronous motor - Synchronous Condenser – Applications.

Learning Outcomes:
After the completion of the course the student should be able to:

- Apply fundamentals in various electrical circuits.
- Explain the operation and characteristics of DC machines.
- Determine the efficiency and regulation of transmission.
- Explain the operation and starting methods of Induction Motors.
- Apply the applications of Synchronous Machines.

Text Books:

1. Principles of Electrical Machines by V.K. Mehta & Rohit Mehta, S.Chand publications
2. Theory & performance of Electrical Machines by J.B.Guptha, S.K.Kataria & Sons
3. Circuit Theory (Analysis and Synthesis) by A. Chakrabarti, Dhanpat Rai & Co.

Reference Books:

1. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah,TMH Publications
2. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications,2nd edition
3. Basic Electrical Engineering by Nagsarkar,Sukhija, Oxford Publications,2nd edition

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		L	T	P	C
III Year –II SEMESTER		**0**	**0**	**3**	**1.5**

POWER ELECTRONICS LABORATORY

Learning objectives:

- To study the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
- To analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
- To understand the operation of AC voltage regulator with resistive and inductive loads.
- To understand the working of Buck converter, Boost converter and inverters.

Any 10 of the Following Experiments are to be conducted

1. Characteristics of Thyristor, MOSFET & IGBT.
2. R, RC & UJT firing circuits for SCR.
3. Single -Phase semi converter with R & RL loads.
4. Single -Phase full converter with R & RL loads.
5. Three- Phase full converter with R &RL loads.
6. Single Phase dual converter in circulating current & non circulating current mode of operation.
7. Single -Phase AC Voltage Regulator with R & RL Loads.
8. Single Phase step down Cycloconverter with R & RL Loads.
9. Boost converter in Continuous Conduction Mode operation.
10. Buck converter in Continuous Conduction Mode operation.
11. Single -Phase square wave bridge inverter with R & RL Loads.
12. Single - Phase PWM inverter.

Learning outcomes:

After the completion of the course the student should be able to:

- study the characteristics of various power electronic devices.
- analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
- understand the operation of single phase AC voltage regulator with resistive and inductive loads.
- understand the working of Buck converter, Boost converter, single–phase square wave inverter and PWM inverter.

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		L	T	P	C
III Year –II SEMESTER		**0**	**0**	**3**	**1.5**
MICRO PROCESSORS AND MICRO CONTROLLERS LAB					

Learning Objectives:

- To study programming based on 8086 microprocessor and 8051 microcontroller.
- To study 8086 microprocessor based ALP using arithmetic, logical and shift operations.
- To study to interface 8086 with I/O and other devices.
- To study parallel and serial communication using 8051& PIC 18 micro controllers.

Any 10 of the following experiments are to be conducted:

I. Microprocessor 8086&Microcontroller 8051

Introduction to MASM/TASM.

1. Arithmetic operation – Multi byte addition and subtraction, multiplication and division – Signed and unsigned arithmetic operation, ASCII – Arithmetic operation.
2. Logic operations – Shift and rotate – Converting packed BCD to unpacked BCD, BCD to ASCII conversion.
3. By using string operation and Instruction prefix**:** Move block, Reverse string Sorting, Inserting, Deleting, Length of the string, String comparison.
4. Interfacing 8255–PPI with 8086.
5. Interfacing 8259 – Interrupt Controller with 8086.
6. Interfacing 8279 – Keyboard Display with 8086.
7. Stepper motor control using 8253/8255.
8. Reading and Writing on a parallel port using 8051
9. Timer in different modes using 8051
10. Serial communication implementation using 8051
11. Understanding three memory areas of 00 – FF Using 8051 external interrupts.
12. Traffic Light Controller using 8051.

Learning Outcomes:

After the completion of the course the student should be able to:

- write assembly language program using 8086 micro based on arithmetic, logical, and shift operations.
- interface 8086 with I/O and other devices.
- do parallel and serial communication using 8051 & PIC 18 micro controllers.

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		L	T	P	C
III Year –II SEMESTER		**3**	**0**	**0**	**0**

EMPLOYABILITY SKILLS

Preamble: This course is introduced to enhance the soft and hard skills of students based on industry needs and helping the student to get the employment in the competitive industrial environment.

Course Objective: In the this course the student should understand:

(i) Aptitude skill (ii) Soft skills (iii) Skills required for campus placement interview

Unit 1: Aptitude Skills

Quantitative Aptitude:

Numbers, HCF and LCM, Problems on ages, Averages, Ratio and Proportion, Percentages, Profit and Loss, Partnership, Interest calculations, Time and Work, Time and Distance, Pipes and Cisterns, Mensuration

Reasoning:

Number and Letter Analogy, Coding and decoding, Odd Man out, Symbols and Notations, Permutations and Combinations, Probability, Data Interpretation, Data Sufficiency, Clocks and Calendars, Deductions, Logical Connectives, Venn Diagrams, Cubes, Binary Logic, Ordering and Sequencing, Blood relations – Syllogisms - Seating arrangement, Analytical Reasoning

Unit 2: Skills - I

Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. **Self-Discovery:** Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. Goal Setting-Vision Vs Mission Vs Goals, SMART Technique to Goal Setting, SWOT Analysis. **Self Esteem:** Types of Self Esteem, Causes of Low Self Esteem, Merits of Positive Self Esteem and Steps to build a positive Self Esteem; Art of Compromise, Learn to Say:'I Don't Know', Being organized, Showing Self-awareness, Self-Assessment for Attainable Career Objectives. **Attitude & Confidence:** Attitude Vs Skills Vs Knowledge, Attitude Vs Behaviour, Developing Positive Attitude and Confidence; Fear-Public Speaking, Steps to Overcome Fear, developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels, Adjusting Your Attitude-Arrogance has no Place in the Workplace, Cultural Sensitivity in the Workplace**,** Corporate Culture: Learning How to Fit in. **Motivational Talk:** Team Work, Team Vs Group, Stages in Team Building, Mistakes to avoid and Lessons to Learn.

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Unit 3: Skills – II:

Interpersonal Communication: Interpersonal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation. **Listening:** Listening Vs Hearing, Possible reasons for why people do not Listen at times, Active Listening Vs Passive Listening, Listening effect on relationships. **Public Speaking:** Skills, Methods, Strategies and Essential tips for effective public speaking. **Group Discussion:** Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective. **Non-Verbal Communication:** Importance and Elements; Body Language-Postures, gestures, eye contact. **Teamwork and Leadership Skills:** Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills. **Presentation Skills:** Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness. **Etiquette and Manners:** Social and Business. **Time Management** – Concept, Essentials, Tips.

Unit 4: Personality Development: Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills. **Decision-Making and Problem-Solving Skills:** Meaning, Types and Models, Group and Ethical Decision-Making, Problems and Dilemmas in application of these skills. **Conflict Management:** Conflict - Definition, Nature, Types and Causes; Methods of Conflict Resolution. **Stress Management:** Stress - Definition, Nature, Types, Symptoms and Causes; Stress Analysis Models and Impact of Stress; Measurement and Management of Stress. **Leadership and Assertiveness Skills:** A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviour; Assertiveness Skills. **Emotional Intelligence:** Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

Unit 5: Group Discussions (GD):
Stages of a GD, GD Vs Debate, Skills assessed in a GD, Blunders to be avoided, Dos & Don'ts, GD-Practice: Conducting practice sessions and Brain Storming Sessions, Evaluation, feedback on their performance
Resume Preparation: Resume Templates, Steps followed for resume preparation, Common mistakes in a resume; Covering letter
Campus Placements Skills: Stages of Campus Placement, Skills assessed in Campus Placements, Changing scenario and its Challenges & How to get ready, Motivational Talk on Positive Thinking: Beliefs, Thoughts, Actions, Habits & Results (Success);
Interview Skills: Types of Interview, Interviewer and Interviewee – in-depth perspectives; Before, During and After the Interview; Tips for Success, Dress code and Grooming, Dos & Don'ts, Skills assessed in an Interview, Mistakes to be avoided, How to equip oneself to excel;

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How to handle the Typical Interview Questions; Mock Interviews: Unconventional HR questions, Practice sessions with Feedback, **Simulated Testing:** Previous model papers of companies,

Business Terminology: Financial Terms such as Debt, Equity, Share, Working Capital, Turnover, Net worth etc; Vision, Mission, Objectives, Goals, Targets

Course Outcomes: After studying this course the student should able to

(i) solve aptitude and reasoning problems (ii) apply the soft skills in dealing the issues related to employability (iii) successful in getting employment in campus placement interview

References:

1) B. K. Mitra, Personality Development and Soft Skills, Oxford University Press, 2011.
2) S.P. Dhanavel, English and Soft Skills, Orient Blackswan, 2010.
3) R.S.Aggarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S.Chand & Company Ltd., 2018.
4) Raman, Meenakshi & Sharma, Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2011.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
SWITCHGEAR AND PROTECTION					

Preamble:
In order to supply power from generating end to receiving end several equipments are connected in to the system. In order to protect the equipments and components against various operating conditions and over voltages protective devices are required to be installed in the system. Topics specified in this subject deal with various types of protective equipments and their working principle including limitations etc.

Learning objectives:
- To provide the basic principles and operation of various types of circuit breakers.
- To study the classification, operation and application of different types of electromagnetic protective relays.
- To explain protective schemes, for generator and transformers.
- To impart knowledge of various protective schemes used for feeders and bus bars.
- To explain the principle and operation of different types of static relays.
- To study different types of over voltages in a power system and principles of different protective schemes for insulation co–ordination.

UNIT–I:
Circuit Breakers
Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon - RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Introduction to oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Concept of Auto reclosing.

UNIT–II:
Electromagnetic Protection
Relay connection – Balanced beam type attracted armature relay - induction disc and induction cup relays–Torque equation - Relays classification–Instantaneous– DMT and IDMT types– Applications of relays**:** Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**:** Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

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UNIT–III:
Generator Protection
Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples.

Transformer Protection
Protection of transformers**:** Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

UNIT–IV:
Feeder and Bus bar Protection
Protection of lines**:** Over current Protection schemes – PSM,TMS - Numerical examples -Carrier current and three zone distance relay using impedance relays–Protection of bus bars by using Differential protection.

UNIT–V:
Static and Digital Relays & Protection against over voltage and grounding
Static relays**:** Static relay components– Static over current relays– Static distance relay– Micro processor based over current relay, block diagram approach of Numerical Relays.

Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters – Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding**:** Solid–resistance–Reactance–Arcing grounds and grounding Practices.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand the principles of arc interruption for application to high voltage circuit breakers of air, oil, vacuum, SF_6 gas type.
- understand the working principle and operation of different types of electromagnetic protective relays.
- students acquire knowledge of faults and protective schemes for high power generator and transformers.
- improves the ability to understand various types of protective schemes used for feeders and bus bar protection.
- understand different types of static relays and their applications.
- understand different types of over voltages and protective schemes required for insulation co–ordination.

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Text Books:

1. Power System Protection and Switchgear by Badari Ram and D.N Viswakarma, TMH Publications
2. Power system protection- Static Relays with microprocessor applications.by T.S.MadhavaRao,TMH

Reference Books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide.,PHI, 2003.
2. Art & Science of Protective Relaying – by C R Mason, Wiley Eastern Ltd.
3. Protection and SwitchGear by BhaveshBhalja, R.P. Maheshwari, Nilesh G.Chothani, Oxford University Press, 2013.

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		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**
OOPS THROUGH JAVA					

Preamble:
This course is designed to impart the programming skills to the students with OOPS concepts. This course covers OOPS principles, inheritance, classes AWT etc.

Learning Objectives:

- Understanding the OOPS concepts, classes and objects, threads, files, applets, swings and act.
- This course introduces computer programming using the JAVA programming language with object-oriented programming principles.
- Emphasis is placed on event-driven programming methods, including creating and manipulating objects, classes, and using Java for network level programming and middleware development

UNIT-I:
INTRODUCTION TO JAVA:
Introduction to OOP, procedural programming language and object oriented language, principles of OOP, applications of OOP, history of java, java features, JVM, program structure.
Variables, primitive data types, identifiers, literals, operators, expressions, precedence rules and associativity, primitive type conversion and casting, flow of control.

UNIT-II:
OBJECTS AND CLASSES:
Classes and objects, class declaration, creating objects, methods, constructors and constructor overloading, garbage collector, importance of static keyword and examples, this keyword, arrays, command line arguments, nested classes.

UNIT-III:
INHERITANCE:
Inheritance, types of inheritance, super keyword, final keyword, overriding and abstract class.
Interfaces, creating the packages, using packages, importance of CLASSPATH and java.lang package. Exception handling, importance of try, catch, throw, throws and finally block, user-defined exceptions, Assertions.

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UNIT-IV:
MULTITHREADING:
Introduction, thread life cycle, creation of threads, thread priorities, thread synchronization, communication between threads. Reading data from files and writing data to files, random access file,

UNIT-V:
APPLETS AND AWT CLASSES:
Applet class, Applet structure, Applet life cycle, sample Applet programs. Event handling: event delegation model, sources of event, Event Listeners, adapter classes, inner classes.

AWT: introduction, components and containers, Button, Label, Checkbox, Radio Buttons, List Boxes, Choice Boxes, Container class, Layouts, Menu and Scrollbar.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand Java programming concepts and utilize Java Graphical User Interface in Program writing.
- write, compile, execute and troubleshoot Java programming for networking concepts.
- build Java Application for distributed environment.
- design and Develop multi-tier applications.
- identify and Analyze Enterprise applications.

Text Books:

1. The complete Reference Java, 8th edition, Herbert Schildt, TMH.
2. Programming in JAVA, Sachin Malhotra, Saurabh Choudary, Oxford.
3. Introduction to java programming, 7th edition by Y Daniel Liang, Pearson.

Reference Books:

1. Swing: Introduction, JFrame, JApplet, JPanel, Componets in Swings, Layout Managers in
2. Swings, JList and JScrollPane, Split Pane, JTabbedPane, JTree, JTable, Dialog Box.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
RENEWABLE ENERGY SYSTEMS					

Preamble:
This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, biomass, fuel cells and geothermal systems.

Learning Objectives:
- To study the solar radiation data, extraterrestrial radiation, radiation on earth's surface.
- To study solar photo voltaic systems.
- To study maximum power point techniques in solar pv and wind energy.
- To study wind energy conversion systems, Betz coefficient, tip speed ratio.
- To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

UNIT–I:
Fundamentals of Energy Systems and Solar energy
Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation**:** Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry – Radiation on tilted surfaces – Numerical problems.

UNIT–II:
Solar Photovoltaic Systems
Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems – Balance of system components - System design**:** storage sizing – PV system sizing – Maximum power point techniques**:** Perturb and observe (P&O) technique – Hill climbing technique.

UNIT–III:
Wind Energy
Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency – Power output of wind turbine – Selection of generator(synchronous, induction) – Maximum power point tracking – wind farms – Power generation for utility grids.

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UNIT–IV:
Hydro and Tidal power systems
Basic working principle – Classification of hydro systems**:** Large, small, micro – measurement of head and flow – Energy equation – Types of turbines – Numerical problems.
Tidal power – Basics – Kinetic energy equation – Turbines for tidal power - Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

UNIT–V:
Biomass, fuel cells and geothermal systems
Biomass Energy**:** Fuel classification – Pyrolysis – Direct combustion of heat – Different digesters and sizing.
Fuel cell**:** Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics.
Geothermal**:** Classification – Dry rock and hot acquifer – Energy analysis – Geothermal based electric power generation
Learning Outcomes:
After the completion of the course the student should be able to:

- analyze solar radiation data, extraterrestrial radiation, and radiation on earth's surface.
- design solar thermal collectors, solar thermal plants.
- design solar photo voltaic systems.
- develop maximum power point techniques in solar PV and wind energy systems.
- explain wind energy conversion systems, wind generators, power generation.
- explain basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems.

Text Books:

1. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition,2013.
2. Non Conventional sources of Energy by G.D.Rai, Kanna Publications.

Reference Books:

1. Energy Science**:** Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press.
2. Solar Energy**:** Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
3. Renewable Energy- Edited by Godfrey Boyle-oxford university.press,3rd edition,2013.
4. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
5. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
6. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
7. Non conventional energy source –B.H.khan- TMH-2nd edition.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3

UTILIZATION OF ELECTRICAL ENERGY
(ELECTIVE-II)

Preamble:

This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives. Another major share of loads is taken by Electric Traction. Utilization of electrical energy in all the above loads is discussed in detail in this course. Energy Storage Systems concepts are also introduced as a part of this course.

Course Educational Objectives:

- To study the basic principles of illumination and its measurements and to design the different types lighting systems.
- To acquaint with the different types of heating and welding techniques.
- To understand the operating principles and characteristics of various motors with respect to speed, temperature and loading conditions.
- To understand the basic principles of electric traction including speed–time curves of different traction services and calculation of braking, acceleration and other related parameters.
- To Introduce the concept of various types of energy storage systems.

UNIT – I:

Illumination fundamentals

Introduction, terms used in illumination–Laws of illumination–Polar curves–Integrating sphere–Lux meter–Sources of light

Various Illumination Methods

Discharge lamps, MV and SV lamps – Comparison between tungsten filament lamps and fluorescent tubes–Basic principles of light control– Types and design of lighting and flood lighting–LED lighting, Energy conservation.

UNIT – II:

Electric Heating

Advantages and methods of electric heating–Resistance heating induction heating and dielectric heating.

Electric Welding

Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding

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UNIT – III:
Selection of Motors
Choice of motor, type of electric drives, starting and running characteristics–Speed control–Temperature rise–Applications of electric drives–Types of industrial loads–continuous–Intermittent and variable loads–Load equalization, Introduction to energy efficient motors.

UNIT – IV:
Electric Traction – I
System of electric traction and track electrification– Review of existing electric traction systems in India– Special features of traction motor– Mechanics of train movement–Speed–time curves for different services – Trapezoidal and quadrilateral speed time curves.

Electric Traction – II
Calculations of tractive effort– power –Specific energy consumption for given run–Effect of varying acceleration and braking retardation–Adhesive weight and braking retardation adhesive weight and coefficient of adhesion–Principles of energy efficient motors.

UNIT – V:
Introduction to energy storage systems
Need for energy storage, Types of energy storage-Thermal, electrical, magnetic and chemical storage systems, Comparison of energy storage technologies-Applications.

Course Outcomes:
After the completion of the course the student should be able to:

- understand various levels of illuminosity produced by different illuminating sources and able to estimate the illumination levels produced by various sources and recommend the most efficient illuminating sources and should be able to design different lighting systems by taking inputs and constraints in view.
- identify most appropriate heating and welding techniques for suitable applications.
- identify a suitable motor for electric drives and industrial applications
- determine the speed/time characteristics of different types of traction systems and determination of various traction parameters.
- know the necessity and usage of different energy storage schemes for different applications.

Text Books:

1. Utilization of Electric Energy – by E. Openshaw Taylor, Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab, DhanpatRai&Sons.
3. “Thermal energy storage systems and applications”-by Ibrahim Dincer and Mark A.Rosen. John Wiley and Sons 2002.

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Reference Books:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International(P)Limited,Publishers,1997.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
DATA BASE MANAGEMENT SYSTEMS (ELECTIVE-II)					

Preamble:
This course is an elective course designed to impart knowledge in data bases to the students which may be useful the SCADA, power system automation, etc. This course covers database principles, Normal forms, Database models, SQL queries, Data storage etc.

Learning Objectives:
- Fundamentals of DBMS.
- Different modes of DBMS.
- Basic query structures and normal forms.
- Control aspects of DBMS.
- File organization and indexing.

UNIT-I:
An Overview of Database Management
Introduction- What is Database System- What is Database-Why Database- Data Independence- Relation Systems and Others- Summary,
Database system architecture, Introduction- The Three Levels of Architecture-The External Level- the Conceptual Level- the Internal Level- Mapping- the Database Administrator-The Database Management Systems- Client/Server Architecture.

UNIT-II:
The E/R Models, The Relational Model, Relational Calculus, Introduction to Database Design, Database Design and Er Diagrams-Entities Attributes, and Entity Sets-Relationship and Relationship Sets-Conceptual Design With the Er Models, The Relational Model Integrity Constraints Over Relations- Key Constraints –Foreign Key Constraints-General Constraints, Relational Algebra and Calculus, Relational Algebra- Selection and Projection- Set Operation, Renaming – Joins- Division- More Examples of Queries, Relational Calculus, Tuple Relational Calculus- Domain Relational Calculus.

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UNIT-III:

Queries, Constraints, Triggers:

The Form of Basic SQL Query, Union, Intersect, and Except, Nested Queries, Aggregate Operators, Null Values, Complex Integrity Constraints in SQL, Triggers and Active Database.

Schema Refinement (Normalization) : Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3 NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF).

UNIT-IV:

Transaction Management and Concurrency Control

Transaction, properties of transactions, transaction log, and transaction management with SQL using commit rollback and save point.

Concurrency control for lost updates, uncommitted data, inconsistent retrievals and the Scheduler. Concurrency control with locking methods : lock granularity, lock types, two phase locking for ensuring serializability, deadlocks, Concurrency control with time stamp ordering : Wait/Die and Wound/Wait Schemes, Database Recovery management : Transaction recovery.

UNIT-V:

Overview of Storages and Indexing, Data on External Storage- File Organization and Indexing – Clustered Indexing – Primary and Secondary Indexes, Index Data Structures, Hash-Based Indexing – Tree-Based Indexing, Comparison of File Organization

Learning Outcomes:

After the completion of the course the student should be able to:

- describe a relational database and object-oriented database.
- create, maintain and manipulate a relational database using SQL
- describe ER model and normalization for database design.
- examine issues in data storage and query processing and can formulate appropriate solutions.
- understand the role and issues in management of data such as efficiency, privacy, security, ethical responsibility, and strategic advantage.
- design and build database system for a given real world problem

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Text Books:

1. Introduction to Database Systems, CJ Date, Pearson
2. Data base Management Systems, Raghurama Krishnan, Johannes Gehrke, TATA McGraw Hill 3rd Edition
3. Database Systems - The Complete Book, H G Molina, J D Ullman, J Widom Pearson

References Books:

1. Data base Systems design, Implementation, and Management, Peter Rob & Carlos Coronel7th Edition.
2. Fundamentals of Database Systems, Elmasri Navrate Pearson Education
3. Introduction to Database Systems, C.J.Date Pearson Education.

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		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**
ADVANCED CONTROL SYSTEMS (ELECTIVE-II)					

Preamble:
This subject aims to study state space, design of state feedback controllers and state observers, describing function and stability analysis including controllability and observability. It also deals with modern control and optimal control systems.

Learning Objectives:

- To familiarize the state space representation in controllable, observable, diagonal and Jordan canonical forms and introduce the concept of controllability and observability tests through canonical forms.
- Design of state feedback controller by pole placement technique and State Observer design.
- Analysis of a nonlinear system using describing function approach and the Lypanov's method of stability analysis of a system.
- Formulation of Euler Laugrange equation for the optimization of typical functionals and solutions.
- Formulation of linear quadratic optimal regulator (LQR) problem by parameter adjustment and solving riccatti equation.

UNIT – I:
State space analysis
State Space Representation in Canonical forms – Controllable canonical form – Observable canonical form – Diagonal Canonical Form - Jordan Canonical Form - Principle of duality – Controllability and observability test from Jordan canonical form and other canonical forms.

UNIT – II:
Design of state feedback controllers and state Observers
Design of state feedback control through pole placement and Ackerman's formula – Design of state observers (Full order & reduced order).

UNIT – III:
Describing function analysis
Introduction to nonlinear systems, Types of nonlinearities, describing functions, stability using describing functions.

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Stability analysis
Stability in the sense of Lyapunov – Lyapunov's stability and Lypanov's instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.

UNIT–IV:
Calculus of variations
Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation.

UNIT –V:
Optimal control
Linear Quadratic Optimal Regulator (LQR) problem formulation – Optimal regulator design by parameter adjustment (Lyapunov method) – Optimal regulator design by Continuous Time Algebraic Riccatti equation (CARE) - Optimal controller design using LQG framework.

Learning Outcomes:
After the completion of the course the student should be able to:

- formulate different state models in canonical forms.
- design of state feedback control using the pole placement technique and state observer design for a given control system.
- analyse of nonlinear system using the describing function technique and determine the stability of a linear autonomous system using lypnov method.
- determine minimization of functionals using calculus of variation studied.
- formulate and solve the LQR problem and riccatti equation.

Text Books:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication

Reference Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition,1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata McGraw–Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

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		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**
ELECTRICAL MACHINE DESIGN (ELECTIVE-II)					

Preamble:
This course is enables students to design transformers and rotating machines. Design is the prime job of the engineer. This course will provide insight into fundamentals of electrical machine design.

Learning Objectives:
- To understand the basics of design and cooling methods of rotating machines.
- To understand the design of DC machines.
- To understand the design concepts of transformers.
- To understand the design concepts of Induction motor.
- To understand the design concepts of Synchronous machines.

UNIT -I:
Fundamental Aspects of Electrical Machine Design
Design of machines - design factors - limitation in design - modern trends in electrical machine design – types of magnetic and insulating materials – modes of heat dissipation – cooling of rotating machines – methods of cooling.

UNIT -II:
Design of DC Machines
Construction details – design of different windings – output equation –selection of specific magnetic and electric loadings - separation of D and L – estimation of number of conductors, armature slots and conduct dimensions – choice of number of poles and calculation of length of airgap – design of field systems, interpoles and brushes.

UNIT -III:
Design of transformers
Transformer windings – output equation – determination of number of turns and length of mean term – design of core - choice of flux density – resistance and leakage reactance – no load current calculation – losses and efficiency – design of efficiency - cooling of transformers-calculation of number of tubes.

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UNIT -IV:

Design of Induction motors

Comparison between squirrel cage and wound rotors – choice of average flux density and ampere conduction for meter – output equation – design of stator slots and rotor slots – design of no load current – dispersion coefficient and its effects on performance of induction motor.

UNIT -V:

Design of Synchronous Machines

Types of construction – output equation - main dimensions – short circuit ration and its effects on the performance – design of rotor – temperature rise and its effects.

Learning Outcomes:

After the completion of the course the student should be able to:

- design main dimensions of rotating machines.
- design transformers and determine main dimensions.
- design field circuit of DC machines and Synchronous machines.
- design armature of DC machines and AC machines.

Text Books:

1. “Electrical Machines Design” , A.K.Sawhney, Dhanpath Rai & Co.

Reference Books:

1. “Performance and Design of DC Machines”, Clayton & Hancock, ELBS.
2. “Performance and Design of AC Machines”, M.G.Say; Pitman, ELBS.

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IV Year – I SEMESTER		L	T	P	C
		3	0	0	3
HYBRID ELECTRIC VEHICLES (Elective-II)					

Preamble:
This course aims to study and understand merits of electric and hybrid electric vehicles. It also deals with different power electronic converters and battery storage systems for electric and hybrid electric vehicles.

Learning Objectives:
- To familiarize the students with the need and advantages of electric and hybrid electric vehicles.
- To known various architectures of hybrid electric vehicles.
- To understand the power management of plug in electric vehicles.
- To study and understand different power converters used in electrical vehicles.
- To familiarize with different batteries and other storage systems.

UNIT– I:
Introduction
Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles, advantages and applications of Electric and Hybrid Electric Vehicles, different Motors suitable for of Electric and Hybrid Electric Vehicles.

UNIT–II:
Hybridization of Automobile
Architectures of HEVs, series and parallel HEVs, complex HEVs.Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT–III:
Plug-in Hybrid Electric Vehicle
PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.

UNIT–IV:
Power Electronics in HEVs
Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

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UNIT– V:
Battery and Storage Systems
Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource

Learning Outcomes:
After the completion of the course the student should be able to:

- know the concept of electric vehicles and hybrid electric vehicles.
- familiar with different configuration of hybrid electric vehicles.
- understand the power converters used in hybrid electric vehicles
- know different batteries and other energy storage systems.

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co, 2007.

ResearchBooks:

1. Pistooa G., “Power Sources , Models, Sustanability, Infrstructure and the market”, Elsevier 2008
2. Mi Chris, Masrur A., and Gao D.W., “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

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IV Year –I SEMESTER		L	T	P	C
		3	0	0	3
	SWAYAM COURSE				

(ELECTIVE-II)

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
OPERATING SYSTEMS (ELECTIVE-III)					

Preamble:
This is an elective course introduced to understand the principles of operating systems used in SCADA, Power Systems Automation. This courses cover the operating system process scheduling, inter process communication, memory management, synchronization, file system and types of operating systems

Learning Objectives:

- Study the basic concepts and functions of operating systems.
- Understand the structure and functions of OS.
- Learn about Processes, Threads and Scheduling algorithms.
- Understand the principles of concurrency and Deadlocks.
- Learn various memory management schemes.
- Study I/O management and File systems.
- Learn the basics of Linux system and perform administrative tasks on Linux Servers.

UNIT I:
Introduction to Operating System and Concept Process Management
Types of operating systems, operating systems concepts, operating systems services, Introduction to System call, System call types. Process concept, The process, Process State Diagram , Process control block, Process Scheduling- Scheduling Queues, Schedulers, Operations on Processes, Interprocess Communication, Threading Issues, Scheduling-Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

UNIT-II:
Memory Management
Swapping, Contiguous Memory Allocation, Paging, structure of the Page Table, Segmentation
Virtual Memory Management
Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing

UNIT-III:
Concurrency
ProcessSynchronization, The Critical- Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization examples
Principles of deadlock
System Model, Deadlock Characterization, Deadlock Prevention, Detection and Avoidance, Recovery form Deadlock

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UNIT-IV:
File system Interface
The concept of a file, Access Methods, Directory structure, File system mounting, file sharing, protection.
File System implementation- File system structure, allocation methods, free-space management
Mass-storage structure overview of Mass-storage structure, Disk scheduling, Device drivers,

UNIT V:
Linux System
Components of LINUX, Interprocess Communication, Synchronisation, Interrupt, Exception and System Call.
Android Software Platform
Android Architecture, Operating System Services, Android Runtime Application Development, Application Structure, Application Process management

Learning Outcomes:
After the completion of the course the student should be able to:

- design various Scheduling algorithms.
- apply the principles of concurrency.
- design deadlock, prevention and avoidance algorithms.
- compare and contrast various memory management schemes.
- design and Implement a prototype file systems.
- perform administrative tasks on Linux Servers
- introduction to Android Operating System Internals

Text Books:
1. Operating System Concepts,Abraham Silberschatz, Peter Baer Galvin and Greg Gagne 9th Edition, John Wiley and Sons Inc., 2012.
2. Operating Systems – Internals and Design Principles, William Stallings, 7th Edition, Prentice Hall, 2011.
3. Operating Systems-S Halder, Alex A Aravind Pearson Education Second Edition 2016 .

References Books:
1. Modern Operating Systems, Andrew S. Tanenbaum, Second Edition, Addison Wesley, 2001.
2. Operating Systems: A Design-Oriented Approach,Charles Crowley, Tata Mc Graw Hill Education", 1996.
3. Operating Systems: A Concept-Based Approach, D M Dhamdhere, Second Edition, Tata Mc Graw-Hill Education, 2007.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
NEURAL NETWORKS AND FUZZY LOGIC (Elective-III)					

Preamble:
This course introduces the basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks. Also deals with Associate Memories and introduces Fuzzy sets and Fuzzy Logic system components. The Neural Network and Fuzzy Network system application to Electrical Engineering is also presented. This subject is very important and useful for doing Project Work.

Learning Objectives:
- To understand artificial neuron models & learning methods of ANN.
- To utilize different algorithms of ANN.
- To distinguish between classical and fuzzy sets.
- To understand different modules of fuzzy controller.
- To understand applications of neural networks and fuzzy logic.

Unit – I:
Introduction
Artificial Neural Networks (ANN) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised, unsupervised and reinforced) – Neural networks learning rules. Single layer feed forward neural networks: concept of pattern and its types, perceptron training and classification using Discrete and Continuous perceptron algorithms– linear separability- XOR function.

Unit- II:
ANN Paradigms
Multi-layer feed forward networks –Generalized delta rule– Back Propagation algorithm – Radial Basis Function (RBF) network. Kohonen's self organizing feature maps (KSOFM), Learning Vector Quantization (LVQ)– Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

Unit–III:
Classical and Fuzzy Sets
Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.

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UNIT IV:
Fuzzy Logic Modules
Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

UNIT V:
Applications
Neural network applications: Load flow studies, load forecasting, reactive power control.
Fuzzy logic applications: Economic load dispatch, speed control of DC motors, single area and two area load frequency control.

Learning Outcomes:
After the completion of the course the student should be able to:

- know different models of artificial neuron & Use learning methods of ANN.
- use different paradigms of ANN.
- classify between classical and fuzzy sets.
- use different modules of Fuzzy logic controller.
- apply Neural Networks and fuzzy logic for real-time applications.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.

Reference Books:

1. Artificial Neural Network – B.Yegnanarayana, PHI, 2012.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc, 1997.
3. Introduction to Neural Networks using MATLAB 6.0 – S N Sivanandam,SSumathi,S N Deepa TMGH
4. Introduction to Fuzzy Logic using MATLAB – S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

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		3	0	0	3

HIGH VOLTAGE ENGINEERING
(ELECTIVE-III)

Preamble:
With the growth of power, HV power transmission has become an important subject. The performance of generating equipment requires knowledge of different phenomena occurring at higher voltage. Thus evaluations of various insulating materials are required for protection of HV equipments. Keeping this in view the course is designed to understand various phenomena related to breakdown study and withstand characteristics of insulating materials. The course also describes the generation and measurement of DC, AC and Impulse voltages as well various testing techniques.

Learning Objectives:
- To understand HV breakdown phenomena in gases, liquids and solids dielectrics.
- To acquaint with the generating principle of operation and design of HVDC, AC and Impulse voltages and currents.
- To understand various techniques for AC, DC and Impulse measurement of high voltages and currents.
- To understand the insulating characteristics of dielectric materials.
- To understand the various testing techniques of HV equipments.

UNIT–I:
Break down phenomenon in gaseous, liquid and solid insulation
Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice.

UNIT–II:
Generation of High voltages and High currents
Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents – Tripping and control of impulse generators.

UNIT–III:
Measurement of high voltages and High currents
Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.

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UNIT–IV:
Non–destructive testing of material and electrical apparatus
Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements.

UNIT–V:
High voltage testing of electrical apparatus
Testing of insulators and bushings – Testing of isolators and circuit breakers – Testing of cables – Testing of transformers – Testing of surge arresters – Radio interference measurements.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand theory of breakdown and withstand phenomenon for all types of dielectric materials.
- acquaint with the techniques of generation of AC,DC and Impulse voltages.
- apply knowledge for measurement of high AC,DC, Impulse voltages and currents.
- be in a position to measure dielectric property of materials used in HV equipment.
- know the testing techniques of various equipments used in HV engineering.

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier,2nd Edition.
2. High Voltage Engineering and Technology by Ryan, IET Publishers.

Reference Books:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition
2. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
3. High Voltage Insulation Engineering by RavindraArora, Wolfgang Mosch, New Age International (P)Limited,1995.

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COURSE STRUCTURE-R19

		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**

ENERGY AUDITING AND DEMAND SIDE MANAGEMENT
(ELECTIVE-III)

Preamble:

This course is developed to cater the current needs of the industry. This course covers topics in energy conservation. It also covers energy efficient lighting system. The student will learn power factor improvement techniques, energy efficiency in HVAC systems. In addition The economic aspects such as payback period calculations, life cycle costing analysis is covered in this course.

Learning Objectives:

- To understand energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Unit–I:

Energy sources

Energy consumption – world energy reserves – prices – alternative sources – power – energy policies – choice of fuels.

Energy Auditing

Energy conservation schemes: Short term - Medium term - Long term energy conservation schemes – Industrial energy use - Energy index – Cost index .
Representation of energy consumption: Pie charts - Sankey diagrams – Load Profile.
Energy auditing: General Auditing, Detailed Energy Audit.

Unit–II:

Heat Transfer Theory

Heat – Heat content – Rate of heat transfer – Heat transfer coefficient - Conduction – Convention and radiation. Thermal insulation & its importance - space heating – HVAC system – Heating of Buildings – District heating – Factors & affecting the choice of district heating.

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Unit–III:
Energy Efficient Instruments
Digital Energy Meter – Data loggers – Thermo couples – Pyranometer – Lux meters – Tong testers – Power analyzers – Power factor – effects with non-linear loads – effect of harmonics on power factor – Power Factor Improvement – Capacitor rating - Effects of power factor improvements - Electric lighting – Types of lighting – Luminaries – Energy efficient lighting.

Unit–IV
Economic Aspects and Financial Analysis
Understanding energy cost: Depreciation methods – time value of money – rate of return – present worth method. Basic payback calculations –depreciation – net present value calculations. Taxes and tax credit – numerical problems.

Unit–V
Demand Side Management
Introduction to DSM - concept of DSM - benefits of DSM - different techniques of DSM – time of day pricing - multi-utility power exchange model - time of day models for planning. Load management - load priority technique - peak clipping - peak shifting - valley filling - strategic conservation - energy efficient equipment. Management and organization of energy conservation awareness programs.

Learning Outcomes:
After the completion of the course the student should be able to:

- explain energy efficiency, conservation and various technologies.
- design energy efficient lighting systems.
- calculate power factor of systems and propose suitable compensation techniques.
- explain energy conservation in HVAC systems.
- calculate life cycle costing analysis and return on investment on energy efficient technologies.

Text Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill

Reference Books:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.

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2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
5. Industrial Energy Management Systems by Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
6. Fundamentals of Energy Engineering by Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.
7. Economic Analysis of Demand Side Programs and Projects - California Standard Practise Manual, June 2002 – Free download available online
8. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
9. Industrial Energy Management Systems by Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
10. Fundamentals of Energy Engineering by Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.
11. Economic Analysis of Demand Side Programs and Projects - California Standard Practice Manual, June 2002 – Free download available online

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		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**
DATA ANALYTICS WITH PYTHON					

Course Objectives:
The objective of the course is to

- Provide with the knowledge and expertise to become a proficient data scientist
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science
- Learn to statistically analyze a dataset
- Critically evaluate data visualizations based on their design and use for communicating stories from data

Course Outcomes:
At the end of the course, student will be able to

- Describe what Data Analysis is and the skill sets needed to be a data scientist
- Explain in basic terms what Statistical Inference means.
- Identify probability distributions commonly used as foundations for statistical modelling, Fit a model to data
- Use Python to carry out basic statistical modeling and analysis
- Apply basic tools (plots, graphs, summary statistics) to carry out Data Analysis

UNIT I
Statistical Thinking in the Age of Big Data. Exploratory Data Analysis, The Data Science Process
Machine Learning Algorithms, Linear Regression, k-Nearest Neighbors (k-NN), k-means, Logistic Regression

UNIT II
Python Language Basics, IPython, and Jupyter Notebooks: The Python Interpreter, IPython Basics, Python Language Basics, Built-in Data Structures, Functions, and Files, NumPy Basics: Arrays and Vectorized Computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics

UNIT III
Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format
Binary Data Formats, Interacting with Web APIs, Interacting with Databases
Data Cleaning and Preparation: Handling Missing Data, Data Transformation, String Manipulation

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UNIT IV

Data Wrangling: Join, Combine, and Reshape
Hierarchical Indexing, Combining and Merging Datasets, Reshaping and Pivoting
Plotting and Visualization: A Brief matplotlib API Primer, Plotting with pandas and seaborn
Other Python Visualization Tools

UNIT V

Data Aggregation and Group Operations: GroupBy Mechanics
Data Aggregation, Apply: General split-apply-combine, Pivot Tables and Cross-Tabulation
Time Series: Date and Time Data Types and Tools, Time Series Basics, Date Ranges, Frequencies, and Shifting, Time Zone Handling, Periods and Period Arithmetic, Resampling and Frequency Conversion, Moving Window Functions.

Text Books:

1) Doing Data Science: Straight Talk From The Frontline, 1st Edition, Cathy O'Neil and Rachel Schutt, O'Reilly, 2013.
2) McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".

Reference Books:

1) Anderson Sweeney Williams (2011). Statistics for Business and Economics. "Cengage Learning".
2) Douglas C. Montgomery, George C. Runger (2002). Applied Statistics & Probability for Engineering. "John Wiley & Sons, Inc"
3) Jiawei Han and Micheline Kamber (2006). "Data Mining: Concepts and Techniques."
4) "Algorithms for Data Science", 1st Edition, **Steele**, Brian, **Chandler**, John, **Reddy,** Swarna, springers Publications, 2016.

e-Resources:

1) https://nptel.ac.in/courses/106/107/106107220/

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		L	T	P	C
IV Year –I SEMESTER		**3**	**0**	**0**	**3**
SWAYAM COURSE(ELECTIVE-III)					

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		L	T	P	C
IV Year –I SEMESTER		**0**	**0**	**2**	**1**

LINEAR & DIGITAL IC APPLICATIONS LAB

Learning Objective:

- To study the characteristics of Integrated circuits – IC 741, 555, 565.
- To develop the application circuits using IC's.
- To model the digital circuits for different applications.

List of experiments:

1. Determination of parameters like input & output offset voltages and currents, Slew rate, CMRR of op amp 741.
2. Inverting & Non Inverting Amplifiers.
3. Adders & Subtractors.
4. Integrator & Differentiator.
5. Active filter circuits: LPF & HPF (First Order)
6. IC 555 – Monostable & Astable Multivibrators Circuits
7. IC 556, 565-VCO & PLL applications.
8. Multiplexers & De-multiplexers.
9. MOD counter design using D & JK Flipflop.
10. Universal Shift Register.
11. 3-8 Decoder using 74138.
12. Schmitt Trigger circuit using IC 741.
13. ADC using IC 0809 & DAC using IC 741 circuits.

Learning Outcomes:

After the completion of the course the student should be able to:

- understand the characteristics of ICs-741, 555, 565, 566.
- apply the concepts of IC 741 for different applications.
- analyse the data connection circuits.
- develop the digital circuits.
- model the counters & Registers using IC's.

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IV Year – I SEMESTER		L	T	P	C
		0	0	2	1
POWER SYSTEMS & SIMULATION LAB					

Learning Objectives:

To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Any 10 of the Following experiments are to be conducted:

1. Sequence impedances of 3 phase Transformer.
2. Sequence impedances of 3 phase Alternator by Fault Analysis.
3. Sequence impedances of 3 phase Alternator by Direct method.
4. ABCD parameters of Transmission line.
5. Load flow studies using Gauss-seidel method
6. Load flow studies using N-R method..
7. Load frequency control of two area with &without control
8. Economic load dispatch with & without losses
9. Transient analysis of single machine connected to infinite bus(SMIB).
10. Modeling of transformer and simulation of lossy transmission line.
11. Analysis of three phase circuit representing the generator transmission line and load. Plot three phase currents & neutral current.
12. Simulation of transient response of RLC circuits

a) Response to pulse input
b) Response to step input
c) Response to sinusoidal input

13. Simulation of single–phase full converter using RLE loads and single phase AC voltage controller using RL loads
14. Plotting of Bode plots, root locus and nyquist plots for the transfer functions of systems up to 5th order

Learning Outcomes:

After the completion of the course the student should be able to:

- determine the parameters of various power system components which are frequently occur in power system studies and he can execute energy management systems functions at load dispatch center.

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		L	T	P	C
IV Year –I SEMESTER		**0**	**0**	**2**	**1**
INDUSTRIAL TRAINING /SKILL DEVELOPMENT PROGRAMS/ RESEARCH PROJECT					

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		L	T	P	C
IV Year –I SEMESTER		**0**	**0**	**4**	**2**
PROJECT-I					

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		L	T	P	C
IV Year –II SEMESTER		**3**	**0**	**0**	**3**
POWER SYSTEM OPERATION AND CONTROL					

Preamble:
This subject deals with Economic operation of Power Systems, Hydrothermal scheduling and modeling of turbines, generators and automatic controllers. It emphasizes on single area and two area load frequency control and reactive power control.

Learning Objectives:
- To understand optimal dispatch of generation with and without losses.
- To study the optimal scheduling of hydro thermal systems.
- To study the optimal unit commitment problem.
- To study the load frequency control for single area system with and without controllers
- .To study the load frequency control for two area system with and without controllers
- To understand the reactive power control and compensation of transmission lines.

UNIT–I:
Economic Operation of Power Systems
Optimal operation of Generators in Thermal power stations, – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

UNIT–II:
Hydrothermal Scheduling & Unit Commitment
Optimal scheduling of Hydrothermal System**:** Mathematical Formulation – Solution Technique. Optimal unit commitment problem – Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming.

UNIT–III:
Load Frequency Control-I
Modeling of steam turbine – Generator – Mathematical modeling of speed governing system – Transfer function – Necessity of keeping frequency constant – Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

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UNIT–IV:
Load Frequency Control-II
Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case. Tie-line bias control. Load Frequency Control and Economic dispatch control.

UNIT–V:
Compensation in Power Systems
Overview of Reactive Power control – Reactive Power compensation in transmission systems – Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – compensated transmission lines – Introduction of FACTS devices – Types of FACTS devices - Need of FACTS controllers.

Learning Outcomes:
After the completion of the course the student should be able to:

- compute optimal scheduling of Generators.
- understand hydrothermal scheduling.
- understand the unit commitment problem.
- understand importance of the frequency.
- understand importance of PID controllers in single area and two area systems.
- understand reactive power control and compensation for transmission line.

Text Books:

1. Power Generation, Operation and Control by Allen J Wood, Bruce F WollenBerg 3rd Edition, Wiley Publication 2014.
2. Electric Energy systems Theory – by O.I.Elgerd, Tata McGraw–hill Publishing Company Ltd., Second edition.
2. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata McGraw Hill Publishing Company Ltd, 2nd edition.

Reference Books:

1. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., Thompson, 3rdEdition.
3. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
4. Power System Analysis by HadiSaadat – TMH Edition.
5. Power System stability & control, PrabhaKundur,TMH

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
MEASUREMENTS AND INSTRUMENTATION (OPEN ELECTIVE-II)					

Preamble:
This course introduces the principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Learning Objectives:

- To study the principle of operation and working of different types of instruments for measurement of Electrical Quantities.
- To study the working principle of operation of different types of instruments for measurement of power and power factor.
- To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
- To understand the principle of operation and working of transducers.
- To study the principle of operation and working of DVMS, Power analyser and applications of CRO.

UNIT–I:
Analog Ammeter and Voltmeters
Classification – deflecting, control and damping torques,– PMMC, Moving Iron type and Electrostatic instruments, Construction, Torque equation, advantages and disadvantages. Instrument transformers: Current Transformer and Potential Transformer-construction, theory, (Without derivation of ratio and phase angle error) - Numerical Problems.

UNIT –II:
Analog Wattmeters and Power Factor Meters
Electrodynamometer type wattmeter (LPF and UPF), Power factor meters: Dynamometer and M.I type (Single phase), construction, theory, torque equation, advantages and disadvantages - Numerical Problems.

UNIT – III:
Measurements of Electrical parameters
DC Bridges: Method of measuring low, medium and high resistance – Kelvin's double bridge for measurement low resistance, Wheatstone bridge for measurement of medium resistance - Loss of charge method for measurement of high resistance, Megger – measurement of earth resistance - Numerical Problems.

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AC Bridges: Measurement of inductance and quality factor, Maxwell's bridge, measurement of capacitance and loss angle, Desauty's bridge, Schering Bridge, Wien's bridge- Numerical Problems.

UNIT – IV:
Transducers
Classification, Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge, Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, Digital shaft encoders, Hall effect sensors- Numerical Problems.

.

UNIT – V:
Digital meters

Digital voltmeter – Successive approximation DVM, – Digital frequency meter, Digital multimeter, Digital tachometer, Digital Energy Meter, LCRQ - Meter,

Learning Outcomes:
After the completion of the course the student should be able to:

- choose right type of instrument for measurement of ac and dc Electrical quantities.
- choose right type of instrument for measurement of power and power factor.
- select right type for measurement of R, L,C.
- understand the effectiveness of Transducer.
- understand Digital Meters.

Text Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.

Reference Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney Dhanpat Rai &Co.Publications.
2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand.
3. Electrical Measurements by Buckingham and Price, Prentice – Hall
4. Electrical Measurements by Forest K. Harris. John Wiley and Sons
5. Electrical Measurements: Fundamentals, Concepts, Applications by Reissland, M.U, New Age International (P) Limited, Publishers.
6. Electrical and Electronic Measurements by G.K.Banerjee, PHI Learning Private Ltd, New Delhi–2012.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
FUNDAMENTALS OF UTILIZATION OF ELECTRICAL ENERGY (OPEN ELECTIVE -II)					

Preamble:

In the modern society, every engineer is using electrical energy irrespective of their branch of specialization. To provide knowledge about the various electrical energy utilization technologies to non-electrical engineering students this course is developed. In this course, a detailed description about the various sources of electrical energy, illumination requirements and energy conservation, various techniques used for heating & welding applications, and brief description about the electric traction are presented. At the end of the course, an insight in to the importance, techniques, and testing of electrical equipment earthing is also presented.

Learning Objectives:

- To know various sources of electrical energy, methods used for generation of electrical energy.
- To study the various types of Illumination equipment, measurement of Illumination, Illumination techniques.
- To know the various technologies used for heating and welding applications using electrical energy.
- To know the various systems of traction, equipment used for traction.
- To understand the importance of earthing, earthing equipment and earthing measurement of electrical equipment.

Unit-I:

Sources of Electrical Energy

Conventional Sources: Schematic & description of components of thermal power plant - hydro electric power station and nuclear power plants.

Non-conventional sources: schematic and description of components - Solar power generation - Wind power generation – Tidal - Geo-Thermal - Bio energy - Fuel cells technology.

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Unit-II:
Illumination
Introduction, source of light, term used in illumination - Lux meter - Discharge lamp - MV and SV lamps - types and design of light as flood light - LED light - shed lighting and domestic light - conservation of energy.

Unit-III:
Heating and Welding
Advantages of Electric heating - types of electric heating - Resistance Heating - properties of heating element - direct heating - indirect heating - Induction heating - Factors effecting heat – Characteristics – application - description of direct core - vertical core - indirect core and core less type of Induction heating - Dielectric heating – applications of dielectric heating. Advantages of heating – arc furnace – direct arc furnace – indirect arc furnace.
Welding: Introduction - Resistance welding – Spot welding – Projection welding –Seam welding – Butt welding – Arc welding – Metal arc welding – Helium arc welding – carbon arc welding – Hydrogen arc welding.

Unit IV:
Traction
Introduction – Advantages and disadvantages - systems of traction – classification – speed-time curve for different service – various factors affecting the energy consumption – components of electric locomotive (for collecting and discharging) – description of each component.

Unit -V:
Grounding
Introduction – earth and safety – nature of an electrode system – earth conductor sizes – design of earthing electrodes – earthing system – substation earthing mats – earthing practices – earth testing: methodology - earth tester and use

Learning Outcomes:
After the completion of the course the student should be able to:

- know the various sources of electrical energy and its generation technologies for conventional and non-conventional energy sources.
- know various types of illumination equipment, illumination measurement and illumination techniques.

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- learn about various methods used for electrical energy based heating and welding applications.
- know about the mechanisms, equipment and technology used in the electric traction.
- understand the importance of electrical earthing, earthing equipment and electrical earthing measurement methods.

Text Books:

1. Electrical Power Systems(Generation, Transmission, Distribution, Protecection and Utilization of Electrical Energy) – Dr. S.L.Uppal and Prof. Sunil S.Rao – Khanna Publisher, 15th edition, 1987.
2. Electric Power Distribution – A S Pabla – McGrawHill.

Reference Books:

1. Generation Distribution and Utilization of Electrical Energy – C.L.Wadhwa- New Age International Publishers- revised third edition.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
CONCEPTS OF POWER SYSTEM ENGINEERING (OPEN ELECTIVE-II)					

Preamble:
This course introduces the basic concepts and overall view and basic knowledge regarding the power system engineering. The Course is giving the concepts of power generation, power transmission and distribution. It also covers protection, economics and power factor improvement concepts. This subject is very much useful to gain knowledge in the power sytems.

Learning Objectives:
- To understand the types of power plants.
- To understand the concepts of transmission and distribution
- To gain the knowledge of protection and grounding
- To know the economic aspects of electrical energy.
- To learn the importance of power factor improvement and voltage control.

UNIT–I:
Power Generation Concepts & Types
Generation and sources of Energy – Generating stations: Schematic arrangements of Steam Power Plant – Hydro Power Plant - Nuclear Power Plant – Gas Power Plants working principle and Schematic diagram approach only– Comparison between Power Plants.

UNIT–II:
Transmission and Distribution Concepts
Types of Conductors Materials - Constants of Transmission Line – Classification of Overhead Transmission Lines – Performance of Single Phase Short Transmission Lines – Simple Problems – Basic concept of Sub Station.
Distribution Systems – Connection Schemes of Distribution Systems – Structure of Cables – Differences between Overhead & Underground systems.

UNIT – III:
Protection and Grounding
List of Faults – Basic concepts of fuse - Circuit Breakers – Relays – SF_6 Circuit Breakers – Vacuum Circuit Breakers – Operation of Lightning Arrester – Grounding and its advantages - Methods of Neutral Grounding: Resistance, Reactance and Resonant Grounding – Numerical Problems.

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UNIT–IV:
Economic Aspects
Definitions of Load - Load & Load Duration Curves - Load Factor - Demand Factor – Utilization Factor - Loss Factor – Types of Tariff - Cost of Electrical Energy – Expression for Cost of Electrical Energy – Numerical Problems.

UNIT–V:
Power Factor Improvement and Voltage Control
Power Factor – Effects and Causes of low Power Factor – Power Triangle – Shunt & Series Capacitor Compensation - Numerical Problems – Need of Voltage Control – Types of Voltage regulating Devices.

Learning Outcomes:
After the completion of the course the student should be able to:

- gain knowledge on types of power plants.
- learn about transmission and distribution concepts.
- understsnd protection and grounding methods.
- learn the economic aspects of electrical energy.
- understand the power factor improvement and voltage control.

Text Books:

1. Principles of Power System by V.K.Mehata, Rohit Mehata, S.Chand Publishers.

Reference Books:

1. Electrical Power Systems by C.L.Wadwa, New Age International Publishers.

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		3	0	0	3
BASICS OF CONTROL SYSTEMS (OPEN ELECTIVE-II)					

Preamble :
This course introduces the basic principles of control systems for analyzing LTI systems and investigate their stability.

Learning Objectives:

- To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function
- To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers
- To investigate the stability of closed loop systems using Routh-Hurwitz criterion and analysis by root locus method.
- To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots.
- Ability to formulate state models and analyze the systems. To learn the concepts of Controllability and Observability.

UNIT – I:
Mathematical modeling of control systems
Classification of control systems, open loop and closed loop control systems and their differences, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems, transfer function of DC servo motor – AC servo motor – block diagram algebra – representation by signal flow graph – reduction using Mason's gain formula, Feedback characteristics.

UNIT-II:
Time response analysis
Standard test signals – time response of first and second order systems – time domain specifications, steady state errors and error constants, P, PI,PID Controllers.

UNIT–III:
Stability and rootlocus technique
The concept of stability – Routh-Hurwitz –limitations of Routh-Hurwitz criterion,
Root locus concept – construction of root loci (simple problems).

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UNIT–IV:
Frequency response analysis
Introduction to frequency domain specifications – Polar Plot - Bode diagrams – transfer function from the Bode diagram – phase margin and gain margin – stability analysis from Bode plots.

UNIT–IV:
State space analysis of LTI systems
Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and it's Properties, concepts of controllability and observability.

Learning Outcome:
After the completion of the course the student should be able to:

- derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
- determine time response specifications of second order systems and to determine error constants.
- analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- analyze the stability of LTI systems using frequency response methods.
- represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

Text Books:

1. Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of India.
2. Automatic control systems by Benjamin C.Kuo, Prentice Hall of India,2nd Edition.

Reference Books:

5. Control Systems principles and design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4th Edition.
6. Control Systems by Manik Dhanesh N, Cengage publications.
3. Control Systems Engineering by I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
4. Control Systems Engineering by S.Palani,Tata Mc Graw Hill Publications.

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IV Year – II SEMESTER		L	T	P	C
		3	0	0	3
ENERGY AUDIT (OPEN ELECTIVE-II)					

Preamble:

This is an open elective course developed to cater the current needs of the industry. This course covers topics in energy conservation. It also covers energy efficient lighting system. The student will learn power factor improvement techniques, energy efficiency in HVAC systems. In addition the economic aspects such as payback period calculations, life cycle costing analysis is covered in this course.

Learning Objectives:

- To understand energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Unit–I:

Energy sources

Energy consumption – world energy reserves – prices – alternative sources – power – energy policies – choice of fuels.

Energy Auditing

Energy conservation schemes: Short term - Medium term - Long term energy conservation schemes – Industrial energy use - Energy index – Cost index .
Representation of energy consumption: Pie charts - Sankey diagrams – Load Profile.
Energy auditing: General Auditing, Detailed Energy Audit.

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Unit–II:

Heat Transfer Theory

Heat – Heat content – Rate of heat transfer – Heat transfer coefficient - Conduction – Convention and radiation. Thermal insulation & its importance - space heating – HVAC system – Heating of Buildings – District heating – Factors & affecting the choice of district heating.

Unit–III:

Energy Efficient Instruments

Digital Energy Meter – Data loggers – Thermo couples – Pyranometer – Lux meters – Tong testers – Power analyzers – Power factor – effects with non-linear loads – effect of harmonics on power factor – Power Factor Improvement – Capacitor rating - Effects of power factor improvements - Electric lighting – Types of lighting – Luminaries – Energy efficient lighting.

Unit–IV

Economic Aspects

Costing Techniques – cost factors – break-even charts – sources of capital and hire charges - capital recovery – depreciation – budgeting and standard costing – charging energy – cash flow diagrams and activity charts.

Unit–V

Financial Analysis

Financial appraisal and profitability : investment decision- methods of investment appraisal-discounted cash flow – summary of investment appraisal techniques – Cost optimization – optimization with one variable – optimization with more than one variable.

Learning Outcomes:

After the completion of the course the student should be able to:

- explain energy efficiency, conservation and various technologies.
- design energy efficient lighting systems.
- calculate power factor of systems and propose suitable compensation techniques.
- explain energy conservation in HVAC systems.
- calculate life cycle costing analysis and return on investment on energy efficient technologies.

Text Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill

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Reference Books:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management hand book by W.C.Turner, John wiley and sons.
4. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
5. Industrial Energy Management Systems by Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
6. Fundamentals of Energy Engineering by Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.
7. Economic Analysis of Demand Side Programs and Projects - California Standard Practise Manual, June 2002 – Free download available online

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IV Year –II SEMESTER		L	T	P	C
		3	0	0	3

ELECTRICAL DISTRIBUTION SYSTEMS
(ELECTIVE-IV)

Preamble:
This subject deals with the general concept of distribution system, substations and feeders as well as discusses distribution system analysis, protection and coordination, voltage control and power factor improvement.

Learning Objectives
- To study different factors of Distribution system.
- To study and design the substations and distribution systems.
- To study the concepts of voltage drop and power loss.
- To study the distribution system protection and its coordination.
- To study the effect of compensation for power factor improvement.
- To study the effect of voltage control on distribution system.

UNIT – I:
General Concepts
Introduction to distribution systems - Distribution system losses – Coincidence factor – Contribution factor loss factor – Numerical Problems – Load Modeling and Characteristics – Relationship between the load factor and loss factor – Classification and charcteristics of loads (Residential, commercial, Agricultural and Industrial).

UNIT – II:
Substations
Location of substations**:** Rating of distribution substation – Service area with'n'primary feeders – Benefits and methods of optimal location of substations..
Distribution Feeders
Design Considerations of distribution feeders**:** Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT – III:
System Analysis
Voltage drop and power–loss calculations**:** Derivation for voltage drop and power loss in lines – Uniformly distributed loads and non-uniformly distributed loads – Numerical problems - Three phase balanced primary lines.

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UNIT – IV:
Protection, Coordination & Automation
Objectives of distribution system protection –Time current characteristics – Protective devices**:** Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers, Modulated case circuit breakers, Earth leakage circuit breakers – Protection schemes of parallel & Ringmain feeders.
Coordination of protective devices**:** General coordination procedure –Various types of co-ordinated operation of protective devices - Residual Current Circuit Breaker
Automation: Block diagram approach of SCADA.

UNIT – V:
Compensation for Power Factor Improvement
Capacitive compensation for power factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location – Numerical problems.

Voltage Control
Voltage Control**:** Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR – Line drop compensation – Numerical problems.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand various factors of distribution system.
- design the substation and feeders.
- determine the voltage drop and power loss
- understand the protection and its coordination.
- understand the effect of compensation forp.f improvement.
- understand the effect of voltage control.

Text Book:

1. “Electric Power Distribution system, Engineering” – by TuranGonen, McGraw–hill Book Company.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo, CRC press
2. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4th edition, 1997.
3. Electrical Power Distribution Systems by V.Kamaraju, Right Publishers.

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IV Year –II SEMESTER		L	T	P	C
		3	0	0	3

HVAC & DC TRANSMISSION
(ELECTIVE–IV)

Preamble:
With the increasing power generation in the country and long distance power transmission, it is necessary that power should be transmitted at extra and ultra high voltage. The topics dealt in this subject relate to phenomena associated with transmission line at higher voltages, equipments generating high voltage and power control strategy.

Learning Objectives

- To understand the phenomena associated with transmission line, operating at extra high voltages. The unit gives detail analysis of several phenomena viz. electrostatic field, charges, voltage gradient and conductor configuration.
- The objective is to discuss phenomena of corona, losses, audible noise, radio interference and measurement of these quantities.
- To understand the phenomena of HVDC, HVDC equipment comparison with AC and the latest state of art in HVDC transmission.
- To understand method of conversion of AC to DC, performance of various level of pulse conversionand control characteristics of conversion.It also provides knowledge of effect of source inductance as well as method of power control.
- To understand the requirements of reactive power control and filtering technique in HVDC system.
- To understand the harmonics in AC side of power line in a HVDC system and design of filters for various levels of pulse conversion.

Unit – I:
Introduction of EHV AC transmission
Necessity of EHV AC transmission – Advantages and problems– Power handling capacity and line losses– Mechanical considerations – Resistance of conductors –Electrostatics – Field of sphere gap – Field of line charges and properties – Charge ~ potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius– Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.

Unit – II:
Corona effects
Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN – Relation between 1–phase and 3–phase AN levels – Examples – Radio interference (RI) – Corona pulses generation –

COURSE STRUCTURE-R19

Properties and limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions – Examples.

UNIT – III:
Basic Concepts of DC Transmission
Economics & Terminal equipment of HVDC transmission systems**:** Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC transmission – Application of DC Transmission System – Planning & Modern trends in DC transmission.

UNIT – IV:
Analysis of HVDC Converters and System Control
Choice of Converter configuration – Analysis of Graetz – Characteristics of 6 Pulse & 12 Pulse converters –Cases of two 3 phase converters in star –Star mode and their performance – Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system – Starting and stopping of DC link – Power Control.

UNIT–V:
Reactive Power Control in HVDC and Filters
Reactive Power Requirements in steady state–Conventional control strategies–Alternate control strategies sources of reactive power–AC Filters – Shunt capacitors– Synchronous condensers.

Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters –Design of High pass filters.

Learning Outcomes:
After the completion of the course the student should be able to:

- acquaint with HV transmission system with regard to power handling capacity, losses, conductor resistance and electrostatic field associate with HV. Further knowledge is gained in area of bundle conductor system to improve electrical and mechanical performance.
- develop ability for determining corona, radio interference, audible noise generation and frequency spectrum for single and three phase transmission lines.
- acquire knowledge in transmission of HVDC power with regard to terminal equipments, type of HVDC connectivity and planning of HVDC system.
- develop knowledge with regard to choice of pulse conversion, control characteristic, firing angle control and effect of source impedance.
- develop knowledge of reactive power requirements of conventional control, filters and reactive power compensation in AC. side of HVDC system.

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- calculate voltage and current harmonics, and design of filters for six and twelve pulse conversion.

Text Books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd.

Reference Books:

1. EHVAC and HVDC Transmission Engineering and Practice – S.Rao.
2. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications
3. HVDC Transmission – J.Arrillaga.

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		L	T	P	C
IV Year –II SEMESTER		**3**	**0**	**0**	**3**

FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEMS
(ELECTIVE-IV)

Preamble:
Flexible Alternating Current Transmission System controllers have become a part of modern power system. It is important for the student to understand the principle of operation of series and shunt compensators by using power electronics. As the heart of many power electronic controllers is a voltage source converter (VSC), the student should be acquainted with the operation and control of VSC. Two modern power electronic controllers are also introduced.

Learning Objectives:

- To learn the basics of power flow control in transmission lines using FACTS controllers
- To explain operation and control of voltage source converter.
- To understand compensation methods to improve stability and reduce power oscillations of a power system.
- To learn the method of shunt compensation using static VAR compensators.
- To learn the methods of compensation using series compensators
- To explain operation of Unified Power Flow Controller (UPFC).

Unit–I:
Introduction to FACTS
Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers – Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

Unit–II:
Voltage source and Current source converters
Concept of voltage source converter (VSC) – Single phase full wave bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter – Transformer connections for 12, 24 and 48 pulse operation, concept of Current Source Converter (CSC), Three–phase current source converter – Comparison of current source converter with voltage source converter.

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Unit–III:
Shunt Compensators
Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping – variable Impedance type VAR generator - Thyristor Switched/Controlled Reactor (TSR/TCR) – Thyristor Switched Capacitor(TSC) – Fixed Capacitor–Thyristor Controlled Reactor (FC-TCR), Thyristor Switched Capacitor and Thyristor Controlled Reactor (TSC–TCR), Switching Converter type VAR generator – principle of operation - Comparison of SVC and STATCOM.

Unit IV:
Series Compensators
Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC) - Switching Converter type Series Compensation.

Unit–V:
Combined Controllers
Voltage and Phase Angle Regulator - TCVR and TCPAR – Switched Converter Based Voltage-Phase Angle Regulator - Schematic and basic operating principles of Unified Power Flow Controller (UPFC), Interline Power Flow Controller (IPFC) - Application on transmission lines.

Learning Outcomes:
After the completion of the course the student should be able to:

- understand power flow control in transmission lines using FACTS controllers.
- explain operation and control of voltage source converter.
- analyze compensation methods to improve stability and reduce power oscillations in the transmission lines.
- explain the method of shunt compensation using static VAR compensators.
- understand the methods of compensations using series compensators.
- explain operation of Unified Power Flow Controller (UPFC).

Text Books:

1. “Understanding FACTS” N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:—Standard Publications, 2001.

Reference Books:

1. “Flexible ac transmission system (FACTS)” Edited by Yong Hue Song and Allan T Johns, Institution of Electrical Engineers, London.
2. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R.MohanMathur and Rajiv k.Varma, Wiley.

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		L	T	P	C
IV Year –II SEMESTER		**3**	**0**	**0**	**3**

POWER QUALITY
(ELECTIVE-IV)

Preamble:
Power quality is a major problem for utilities and customers. Customers using sensitive critical loads need quality power for proper operation of the electrical equipment. It is important for the student to learn the power quality issues and improvement measures provided by the utility companies. This course covers the topics on voltage and current imperfections, harmonics, voltage regulation, power factor improvement, distributed generation, power quality monitoring and measurement equipment.

Learning Objectives:
- To learn different types of power quality phenomena.
- To identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
- To describe power quality terms and study power quality standards.
- To learn the principle of voltage regulation and power factor improvement methods.
- To explain the relationship between distributed generation and power quality.
- To understand the power quality monitoring concepts and the usage of measuring instruments.

Unit–I:
Introduction
Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations.

Unit–II:
Voltage imperfections in power systems
Power quality terms – Voltage sags – Voltage swells and interruptions – Sources of voltage sag, swell and interruptions – Nonlinear loads – IEEE and IEC standards. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients.

Unit–III:
Voltage Regulation and power factor improvement:
Principles of regulating the voltage – Device for voltage regulation – Utility voltage

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regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

Unit– IV:
Harmonic distortion and solutions
Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active filtering – Numerical problems.

Unit–V:
Distributed Generation and Power Quality Monitoring
Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts.
Power quality monitoring and considerations – Historical perspective of Power quality measuring instruments – Power quality measurement equipment – Assessment of Power quality measuring data.

Learning Outcomes:
After the completion of the course the student should be able to:

- differentiate between different types of power quality problems.
- explain the sources of voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
- analyze power quality terms and power quality standards.
- explain the principle of voltage regulation and power factor improvement methods.
- demonstrate the relationship between distributed generation and power quality.
- explain the power quality monitoring concepts and the usage of measuring instruments.

Textbooks:

1. Electrical Power Systems Quality, Dugan R C, Mc Granaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw–Hill, 2012, 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley India publications,2011.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, Mc Graw–Hill, 2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition, IEEE Press; 2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.

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4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
5. Power Quality c.shankaran, CRC Press, 2001
6. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
7. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs, Mohammad A.S. Masoum–Elsevier.

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		L	T	P	C
IV Year –II SEMESTER		**3**	**0**	**0**	**3**
SMART GRID (ELECTIVE-IV)					

Preamble:
Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Learning Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid.

Unit-I:
Introduction to Smart Grid
Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

Unit-II:
Smart Grid Technologies: Part 1
Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit-III:
Smart Grid Technologies: Part 2
Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

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Unit-IV:
Micro grids and Distributed Energy Resources
Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

Unit-V:
Power Quality Management in Smart Grid
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid
Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Course Outcomes:
After the completion of the course the student should be able to:

- understand smart grids and analyse the smart grid policies and developments in smart grids.
- develop concepts of smart grid technologies in hybrid electrical vehicles etc.
- understand smart substations, feeder automation, GIS etc.
- analyse micro grids and distributed generation systems.
- analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,“Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley Blackwell 19
5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010

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6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press.

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

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		L	T	P	C
IV Year –II SEMESTER		**3**	**0**	**0**	**3**
SPECIAL ELECTRICAL MACHINES (ELECTIVE - IV)					

Preamble:
This is an advanced course on electrical machines. Students will be exposed to various special machines which are gaining importance in industry. This course covers topics related to principles, performance and applications of these special machines including switched reluctance motors, stepper motors, permanent magnet dc motors and linear motors.

Learning Objective:
- To explain theory of operation and control of switched reluctance motor.
- To explain the performance and control of stepper motors, and their applications.
- To describe the operation and characteristics of permanent magnet dc motor.
- To distinguish between brush dc motor and brush less dc motor**.**
- To explain the theory of travelling magnetic field and applications of linear motors.

Unit I:
Permanent magnet materials and PMDC motors
Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor-Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-high temperature effects-reversible losses-Irreversible losses-Mechanical properties, handling and magnetization-Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty.

Unit II:
Stepper Motors
Principle of operation of Stepper Motor – Constructional details - Classification of stepper motors – Different configuration for switching the phase windings - Control circuits for stepper motors – Open loop and closed loop control of two phase hybrid stepping motor.

Unit III:
Switched Reluctance Motors
Construction and Principle of operation of Switched Reluctance Motor – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.

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Unit IV:
Permanent Magnet Brushless DC Motor
Principle of operation of BLDC motor - Types of constructions - Surface mounted and interior type permanent magnet DC Motors - Torque and EMF equations for Square wave & Sine wave for PMBLDC Motor – Torque - Speed characteristics of Square wave & Sine wave for PMBLDC Motor - Merits & demerits of Square wave & Sine wave for PMBLDC Motor - Performance and efficiency – Applications.

Unit V:
Linear Induction Motors (LIM)
Construction– principle of operation–Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one sided LIM with back iron- equivalent circuit of LIM.

Learning Outcomes:
After the completion of the course the student should be able to:

- distinguish between brush dc motor and brush less dc motor**.**
- explain the performance and control of stepper motors, and their applications.
- explain theory of operation and control of switched reluctance motor.
- explain the theory of travelling magnetic field and applications of linear motors.
- understand the significance of electrical motors for traction drives.

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi.

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