NATIONAL INSTITUTE OF TECHNOLOGY, AGARTALA

DEPARTMENT OF ELECTRICAL ENGINEERING

SYLLABII FOR UG 1st, 2nd, 3rd, 4th, 5th, 6th, 7th & 8th SEMESTERS

Semester		HOUR			CREDIT			
		Lecture	Tutorial	Practical	Lecture	Tutorial	Practical	Total
	First Year (1st Semester+2nd Semester) [already implemented by the academic section in 2018-19 session.]							**43**
3rd Semester								
1	Engineering Mathematics III	3	1	0	3	1	0	4
2	Electrical Measurement and Measuring Instruments	2	1	2	2	1	1	4
3	Network Analysis	3	1	2	3	1	1	5
4	Digital Electronics	3	0	2	3	0	1	4
5	Object Oriented Programming	2	0	3	2	0	1.5	3.5
6	Signals & Systems	2	1	0	2	1	0	3
7	Seminar (Soft Skilled based)	0	0	0	0	0	0	0
								23.5
4th Semester								
1	Electrical Machine-I	3	1	3	3	1	1.5	5.5
2	Power System I	3	1	0	3	1	0	4
3	Data Structure & Algorithm	2	1	0	2	1	0	3
4	Numerical Methods and Analysis	3	1	2	3	1	1	5
5	Analog Electronics	3	1	2	3	1	1	5
6	Elective-I	3	0	0	3	0	0	3
7	Seminar (Soft Skilled based)	0	0	0	0	0	0	0
								25.5
5th Semester								
1	Electrical Machine-II	3	1	3	3	1	1.5	5.5
2	Power Electronics	3	1	3	3	1	1.5	5.5
3	Microprocessors and Microcontroller	3	0	2	3	0	1	4
4	Control System-I	3	1	2	3	1	1	5
5	Electromagnetic Field Theory	3	0	0	3	0	0	3
6	Seminar	0	0	2	0	0	1	1
								24
6th semester								
1	Power System II	3	1	3	3	1	1.5	5.5
2	Digital Signal Processing	3	0	2	3	0	1	4
3	Industrial Instrumentation	3	1	2	3	1	1	5
4	Principle of Communication	3	0	2	3	0	1	4
5	Industrial Visit/ internship							**audit**
6	Seminar	0	0	2	0	0	1	1
								19.5
7th Semester								
1	Electrical Drives	3	0	3	3	0	1.5	4.5
2	Engineering Economics	3	0	0	3	0	0	3
3	Elective II	3	0	0	3	0	0	3
4	Elective III	3	0	0	3	0	0	3
5	Project –I	0	0	6	0	0	2	2
6	Seminar	0	0	2	0	0	1	1
								16.5
8th semester	**(If a student does not participate project in Industry)**							
1	Industrial Management	3	0	0	3	0	0	3
2	Elective IV	3	0	0	3	0	0	3
3	Elective V	3	0	0	3	0	0	3
4	Grand Viva							1
5	Project –II	0	0	9	0	0	3	3
								13
8th semester	**(If a student participates project in Industry)**							
1	Industrial Project							10
2	Project Seminar							2
3	Comprehensive Viva							1
								13
TOTAL							**(43+122) =165**	

3rd Semester

1. Engineering Mathematics III   L T P: 3-1-0   Credit : 04

Probability and statistics-classical and axiomatic definition of probability, conditional probability, independent events, random variables, probability mass function and probability density function, distribution function, function of random variables, standard univariate discrete and continuous distribution and their properties, mathematical expectation, moments, moments generating function, correlation and regression. Function of several variables-partial derivatives, chain rule, differentiation of implicit functions, exact differentials, tangent planes and normal planes, maxima, minima and saddle points, simple problems in extrema of functions with constraints, method of Lagrangian multipliers. Function of a complex variable-limit, continuity and differentiation, analytic function, Cauchy-Riemann equations, conjugate functions, application to two dimensional problems, Cauchy's integral theorem, Taylor's and Laurent's expansions, branch points, zeros, poles, residues, simple problems on contourintegration.

Text Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, Wiley publication, 9thEdition,
2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publication,Delhi.

Referrence Books:

1. H. Bauer, *Probability Theory and Elements of Measure Theory*, Academic Press,1981.
2. P.E. Danko, A.G. Popov, T.YA. Koznevnikova, *Higher Mathematics in Problems and Exercises*, Part 2, Mir Publishers,1983.

Courses objective:

The objectives of the course Engineering Mathematics-III are:

1. The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.
2. Apply probability theory via Bayes' Rule
3. Describe the properties of discrete and continuous distribution functions.
4. Use method of moments and moment generating functions.
5. Apply the Central Limit Theorem.
6. Use statistical tests in testing hypotheses on data.
7. Introduce students to partial differential equations, and to solve linear Partial Differential with different methods.
8. Introduce students to some physical problems in Engineering and Biological models that results in partial differential equations.
9. Introduce the Fourier series and its application to the solution of partial differential equations.

Course content:

Unit-1
Probability and Random Variable: Axioms of probability, Conditional probability, Independent events, Baye's Theorem, Random variables, Probability mass function, Probability density function - properties, Moments, Moment generating functions and their properties.
Unit-2
Standard Distributions: Binomial, Poisson Normal distribution and their properties, function of random variables.
Unit-3
Two-dimensional random variables: Joint distribution, Marginal and conditional distribution, covariance, correlation and regression, Transformation of random variables, Central limit theorem.

Unit-4
Testing of hypothesis: Sampling distribution, Testing of hypothesis of mean, variance, proportion and differences using Normal, t and Chi-square.
Unit- 5
Fourier Series: Periodic functions, Fourier series, Dirichlet's conditions, function defined in two or more sub-ranges, discontinuous functions, even function, odd function, half range series, change of interval.
Unit-6
Partial Differential Equations: Order, Method of forming Partial Differential Equations, Solution of Equation by Direct Integration, Lagrange's Linear equation, Method of Multipliers, Partial Differential equations non-linear in p, q, Charpits Method, Linear Homogeneous Partial Differential equation, Non-Homogeneous Linear Equations, Method of Separation of variables, Equation of vibrating string, Solution of wave equation by D'Alembert's method, One dimensional heat flow, Two dimensional Heat flow.

Course outcome:
At the end of the course, students will be able to

1. Understand the basic concepts of probability, random variables, probability distribution, and moments and moment generating functions.

2. Define the basic discrete and continuous distributions such as normal, binomial, Poisson, and make be able to apply them and simulate them in simple cases.

3. Explain the concepts of tow dimensional random variable, independence, jointly distributed random variables and conditional distributions, and use generating functions to establish the distribution of linear combinations of independent random variables. Also State the central limit theorem, and apply it.

4. Explain the concepts of random sampling, statistical inference and sampling distribution, and state and use basic sampling distributions. Hypothesis testing and its application in real life problems.

5. Find the Fourier series representation of a function of one variable, and find the solution of the wave, diffusion and Laplace equations using the Fourier series.

6. Students familiarize with the fundamental concepts of Partial Differential Equations (PDE) which will be used as background knowledge for the understanding of specialized courses in Engineering. Students will master how solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero.

2. Electrical Measurement & Measuring Instruments
L T P: 2-1-1 Credit : 04

Sensitivity-reliability-accuracy-resolution, error analysis of measurements: Systematic and random errors, propagation of errors; Classification of analog and digital Instrument; Specific analog instruments to be covered: PMMC meter, moving iron type meter and Electrodynamometer type meter; Wattmeters; induction type energy meter; Extension of range for an instrument; instrument transformers: Principle of CT and PT and error; DC potentiometers; Measurement of low, medium and high resistances; Principles of ac bridges; Basics of digital measurements: A/D and D/A converters, programmable gain amplifier-auto-ranging; Introduction to DSO and its specifications; digital voltmeter, ammeter, frequency meter, digital multimeter, Block diagram of LCR meter; Hall effect sensor; clamp-on-meter; static energy meter; Sample and Hold circuit; Data Acquisition Systems

Text Books:

1. N. Kularatna: Digital and Analogue Instrumentation: Testing and Measurement, IET, 2003.

2. HelfrickandCooper,*ModernElectronicInstrumentationandMeasurementTechniques*,Prentice-Hall.
3. E.W. Golding & F.C.Widdis, *Electrical Measurements & Measuring Instruments*, A.H.Wheeler &Co.

Reference Books:

1. F. K. Harris , *ElectricalMeasurement*.
2. Ernest Frank , *Electrical MeasurementAnalysis*.

Courses objective:

1. To introduce students to monitor, analyze and control any physical system.
2. To understand the different analog and digital instruments adopted for measurement of current, voltage, power, energy etc.
3. Know different methods available for measurement of passive elements like resistance, inductance & capacitance.
4. To know the industrial practices of Measuring earth resistance & Testing of underground cables.
5. To introduce students a knowledge to use modern tools necessary for electrical projects.

Course content :

Unit- 1

Sensitivity-reliability- accuracy-resolution, error analysis of measurements.

Unit 2

Classification analogue & digital; Analogue instruments- classification of analog electrical measuring instruments highlighting working principles of indicating, integrating, potentiometric, bridges, electrostatic, electro-dynamic, and thermal type instruments;

Unit – 3

Specific analogue instruments to be covered: moving coil, moving iron (attraction and repulsion types) for voltage and current measurements; single phase wattmeter (induction disc type, electro-dynamic type)-modifications required for measuring three phase power, energy meter, power factor meter; VAR measurement, trivector meter**.**

Unit – 4

Resistance measurement: low resistance (Kelvin double bridge, dc potentiometer), high/insulation resistance (megger), earth resistance; emf measurement using dc potentiometer.

Unit – 5

AC bridges: Maxwell(two versions), Anderson, Schering and Wien bridge and measurement of L,C and internal r/loss factor

Unit – 6

Extension of range for an instrument to measure voltage and current, voltage divider, shunt, instrument transformers, details of CT, working flux, vector diagram, magnitude and phase angle errors and their computations, specific differences for measuring and protection CTs.

Unit – 7

Testing of energy meters- phantom loading tests, different types of errors of an energy meter and their remedies.

Unit –8

Oscilloscope- construction, working principle, measurement of voltage, time & frequency, Lissajous patterns, digital voltmeter, ammeter, frequency meter, resistance meter, energy meter and digital multimeter.

Course outcome:

After successful completion of the course the students will be able to:

1. Appreciate a system to determine appropriate instruments by type and range to measure different quantities in the system.
2. Measure various electrical quantity like R,L,C ,Voltage, Current, Power factor , Power and Energy for ac and dc quantities using analog and digital meters.
3. Balance various ac and dc bridges to find unknown values.
4. Use CRO/DSO with confidence to measure different quantities and viewing signal waves.
5. Measure earth resistance and use techniques and skills to locate the fault of underground cables.

6. Take up projects to apply the learned techniques and skills.

Subject : Electrical Measurement & Measuring Instruments Lab
LTP: 0-0-1 Credit : 01

Courses objective:

1. To know the procedures for measuring Resistance, Inductance and Capacitance of different ranges.
2. To perform experiments to measure current, voltage, power, power factor and energy using analog and digital meters.
3. To design and implement various ac and dc bridges for measuring various electrical quantities like resistance, inductance and capacitance.
4. To know the industrial practices of Measuring earth resistance and insulation resistance of electrical machines.
5. To introduce students a knowledge of using modern tools necessary for electrical projects.

Course content :

Unit- 1
Measurement of voltage and current by using analog meter, digital meters and DSO.
Unit 2
Measurement of Resistance, Inductance and Capacitance of different ranges
Unit – 3
Measurement of power and energy
Unit – 4
Resistance measurement: low resistance (Kelvin double bridge), high/insulation resistance (megger), earth resistance; emf measurement using dc potentiometer, medium resistance measurement by Wheatstone bridge.
Unit – 5
Design and application of ac bridges for measurement of inductance, and capacitance
Unit – 6
Measurement of phase and frequency by CRO.

Course outcome:
After successful completion of the course the students will be able to:
1. Measure various electrical quantities like R,L,C ,Voltage, Current, Power factor , Power and Energy using analog and digital meters.
2. Design various ac and dc bridges to find unknown values.
3. Use CRO/DSO with confidence to measure different quantities and viewing signal waves.
4. Calibrate and test single phase energy meter and calibrate PMMC ammeter.
5. Measure earth resistance and insulation resistance of different electrical machines.
6. Take up projects to apply the learned techniques and skills.

3. Networks Analysis L T P: 3-1-1 Credit: 05

Introduction to circuit elements, types of network, network theorems, transient response. Transform of different signal wave forms, initial and final value. Concept of complex frequency, transform impedances, transform circuit and application of network theorem. Concept of poles and zeros, network functions for one port and two port network, restrictions of poles and zeros location for driving point function and transfer function. Time domain behaviour for the poles and zeros plots. Concept of two port network, impedance parameter, admittance parameter, transmission parameter, inverse transmission parameter, hybrid parameter, inverse hybrid parameter, relation between parameter set, interconnection of two networks, network functions for general networks. Graph of a network, trees, co-trees, loops, incidence matrix, cut-set, tie-set matrix, number of possible trees of a graph, mutual inductance, dot convention, co-efficient of coupling, series andparallel combination of coupled circuit. Classification of passive filters, characteristics, equation of filter networks, resonance, bandwidth and selectivity, quality factor, Introduction to networks synthesis.

Text Books:

1. Franklin Kuo, *Network Analysis And Synthesis*, Wiley international, 2nd edition.
2. M.E. Van Valkenburg, *Network Analysis* , PHI, 3rd edition.

Reference Books:

1. W.H.Hyatt and J.E.Kemmerly , *Engineering Circuit Analysis*,McGraw-Hill.
2. A.E Fitzgerald, David E. Higginbotham, Arvin Grabel, *Basic Electrical Engineering*, McGraw-Hill, 5th Edition.

Courses objective:

1. To attain basic knowledge about the electrical law, different network problems and solution methods of electrical system.
2. Learning network theorems and proper understating of basic components of electrical.
3. To learn and concepts building regarding problem analysis, selecting appropriate solver technique.
4. Understanding the time domain analysis, frequency domain analysis, influence of interconnected network in real time.
5. Learn to apply different mathematical tools in problem analysis.
6. Able to articulate graph theory concept in complex network analysis.

Course content:

Unit- 1

Introduction to circuit elements, types of network, network theorems,

Unit 2

Time domain analysis of network, Transient response. Transform of different signal wave forms, initial and final value.

Unit 3

Concept of complex frequency, transform impedances, transform circuit and application of network theorem.

Unit – 4

Concept of poles and zeros, restrictions of poles and zeros location for driving point function and transfer function. Time domain behavior for the poles and zeros plots.

Unit – 5

Network functions for one port and two port network, network functions for general networks..

Unit – 6

Concept of two port network, impedance parameter, admittance parameter, transmission parameter, inverse transmission parameter, hybrid parameter, inverse hybrid parameter, relation between parameter set, interconnection of two networks,

Unit – 7

Graph of a network, trees, co-trees, loops, incidence matrix, cut-set, tie-set matrix, number of possible trees of a graph.

Unit – 8

Mutual inductance, dot convention, co-efficient of coupling, series and parallel combination of coupled circuit.

Unit – 9

Classification of passive filters, characteristics, equation of filter networks,.

Unit – 10
Resonance, bandwidth and selectivity, quality factor.

Course outcome:

On successful completion of the course, the students will be able to
1. Understand the basic fundamentals of electrical network/ circuit analysis.
2. Apply proper network theorems for electrical network.
3. Find the appropriate solution method/technique for a particular network problem.
4. Able to identify order of the system its description and response type.
5. Analyze passive filter and its application.

Subject: Network Analysis Laboratory L T P: 0-0-1 Credit: 01

Courses objective:

1. To know the practical implementation of theorems.
2. To perform experiments to measure current, voltage, frequency and time constant.
3. To utilize the analog and digital instruments for practical purpose.
4. Understanding particular network problem and verifying it in practice.
5. Able to design circuit parameter accurately and is applied in real time.

Course content :
Unit- 1
Estimation of network voltage, current and power by applying Theorems.
Unit 2
Tracking resonance frequency from a series circuit
Unit – 3
Measuring maximum voltage and minimum current instants and also resonance frequency of a parallel circuit.
Unit – 4
Finding time constants and plotting current and voltage response of a first order circuit
Unit – 5
Verifying charging current of a dc RC network.
Unit – 6
Analysis of system description and its nature for second order circuit
Unit – 7
Determination of Port voltage and current for two port network

Course outcome:
After successful completion of the course the students will be able to:
1. Authenticate the theorems applied to electrical network.
2. Fabricate a network as per desired frequency.
3. Effectively utilize CRO/DSOfor plotting the response with times.
4. Adjust the response of current for first order as well as second order network by selecting suitable value of the component.
5. Verify analog circuit response or result in simulation platform.
6. Relate the reciprocity and symmetry condition of two port network accurately.

4. Digital Electronics L T P: 3-0-1 Credit: 4

Number systems and codes, Boolean algebra, Logic gates, Tristate logic, minimization using Karnaugh map and QM method. Code converters. Finite state machines. Combinational and Sequential logic circuits. Encoders, Decoders.Shift registers, Asynchronous and synchronous counters. Memory: ROM, PROM, EPROM, EEPROM, RAM, Flash memory. Design of ROM, PAL, PLA. MUX and DEMUX etc. Logic families: TTL, ECL, CMOS.

Text Books:

1. H. Taub and D. L. Schilling ,*Digital Integrated Electronics,* McGraw-Hill,1977.
2. M. Morris Mano, *Digital Design*, Prentice Hall, 3rd Edition,2002.

Reference Books:

1. W. I. Fletcher, *An Engineering Approach to Digital Design,* Prentice-Hall1980.
2. T.M. Floyd , R.P. Jain, *Digital fundamentals*, PearsonEducation

Courses objective:

1) To develop a solid ground in basic Digital Circuit Design
2) Explain concepts and terminology of Digital Electronics.
3) To understand and examine the structure of various number systems and its Application in digital design.
4) To develop an understanding for analysis and design of various combinational and sequential circuits.
5) Understanding of logic functions, circuits, truth tables, and Boolean algebra expressions.
6) Provides ability to model, analyze, and test a digital circuit using a computer software application.
7) To develop the ability to identify basic requirements for a design application in a cost effective manner.
8) Also acts as a pre-requisite for subjects like digital communication, microprocessors etc.

Course content:

Unit- 1 Number systems and codes

Conversion of bases, Representation of negative numbers, 1's complement, 2's complement, arithmetic using 2's complement Hexadecimal code, weighted codes - BCD, Excess-3 code, Gray Code. Logic gates and Boolean Algebra.

Unit 2 Boolean function representation and minimization techniques

Standard and canonical representation and minimization of Boolean expressions using Boolean algebra and Karnaugh map.Logic gates, Tristate logic, NAND and NOR gate implementation.

Unit – 3 Combinational Logic Circuits

Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, Code converters, BCD to seven segment decoder, 4-bit magnitude comparator. Multiplexer/de- multiplexers, Encoders and Decoders.

Unit – 4 Sequential Logic Circuits

Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK,. Excitation tables, conversion of Flip Flops. State Diagrams

Unit – 5 Counters

Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Mod-k or divide-by-k counters, Decade counter, BCD counter, Ring counters, Johnson or twisted-ring counter, Counter applications

Unit – 6 Shift registers

Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/ Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

Unit – 7 Memory

ROM, PROM, EPROM, EEPROM, RAM, introduction to memory organization

Unit – 8 Circuit design

Using decoders, MUX and DEMUX etc. Design using multiplexers, ROM, PAL, PLA.

Unit – 9 Llogic families

TTL, ECL, CMOS, calculation of noise margins, fan in and fan-out.

Course outcome:

On successful completion of the course the students will be able to:

1. List the various types of number systems and the digital logic families.

2. Develop a digital logic simplify it and apply it to solve real life problems.

3. Analyse, design and implement Combinational Logic Circuits and Programmable logic devices.

4. Analyse, design and implement Sequential Logic Circuits different semiconductor memories.

5. Analyse digital system design using PLD.

Subject: Digital Electronics Lab L T P: 0-0-1 Credit: 1

Courses objective:

1) Learn the basics of gates.
2) Understanding of logic functions, circuits, truth tables, and Boolean algebra expressions.
3) To develop an understanding for analysis and design of various combinational and sequential circuits.

Course content:

Unit- 1
Familiarization with Logic Gates (AND, OR, NOT, XOR).
Unit 2
Standard and canonical representation and proof of Boolean expressions using Boolean algebra.Deriving truth table.Study of Universal Gates (NAND, NOR).

Unit – 3
Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, Code converters design and proof with truth table.
Unit – 4
Magnitude comparator. Multiplexer/de- multiplexers, Encoders and Decoders design and proof with truth table.
Unit – 5
Latches : SR, D latches design and proof with truth table.

Course outcome:
On successful completion of the course the students will be able to:

1. Explain the basic logic operations of NOT, AND, OR, NAND, NOR, and XOR with truth table.

2. Interpret logic functions, circuits, truth tables, and Boolean algebra expressions and Understand De Morgan's Theorem.

3. Understand various Combinational Logic Design and latches.

5. Object Oriented Programming L T P:2-0-1.5 Credit : 3.5

A look at procedure-oriented programming, object oriented programming paradigm, basic concepts of object oriented programming, benefits of OOP, object oriented languages. Tokens, keywords, identifiers and constants, basic data types, user-defined and derived data types, type compatibility, reference, variables, scope resolution operator, type casting, implicit conversion, operator precedence, control structures, structure, function. Class specification, class objects, accessing class members, data hiding, empty classes, pointers within a class, passing objects as arguments, returning objects from functions, friend functions and friend classes, constant parameters and member functions, structures and classes, static members, objects and memory resource, class design steps. Constructors, destructor, constructor overloading, order of construction and destruction, constructors with default arguments, nameless objects, dynamic initialization through constructors, constructors with dynamic operations, constant objects and constructor, static data members with constructors and destructors, nested classes. Defining operator overloading, overloading unary operators, overloading binary operators, overloading binary operators using friends, manipulation of strings using operators, rules for overloading operators, type conversions. Deriving derived classes, single, multilevel, multiple, hierarchical, hybrid inheritance, constructors & destructors in derived classes, constructors invocation and data members initialization, virtual base classes, abstract classes, delegation. Pointers to objects, this pointer, pointers to derived classes, virtual functions, implementation of run-time polymorphism, pure virtual functions. Classes for file stream operations, opening and closing a file, file pointers and their manipulations, sequential input and output operations, error handling during file operations, command line arguments. Class templates with multiple parameters, function templates, overloading of template functions, member function templates. Object-oriented analysis and design, procedure oriented development tools, prototypingparadigm.

Text Books:

1. Budd, *Object Oriented Programming*, AddisonWesley,
2. K.R Venugopal, Rajkumar, *Mastering C++,*TMH.

Reference Books:

1. Lip man and Lajole, *C++ Primer*, AddisonWesley.
2. B. Stroustrup, *The C++ Programming language*, AddisonWesley

Courses objective:

1.The model of object oriented programming: abstract data types, encapsulation, inheritance and polymorphism.
2.Fundamental features of an object oriented language like C++: object classes and interfaces, exceptions and libraries of object collections.
3.How to take the statement of a business problem and from this determine suitable logic for solving the problem; then be able to proceed to code that logic as a program written in Java.

Course content :

Unit- 1

Introduction

Revision of Important Concepts in C Introduction & Overview From C to C++ Principles of OOP

Unit 2

Classes

Introduction, Operator Overloading, Constructors & Destructors, Predefined C++ Classes in iostream.h, The Copy constructor.

Unit – 3

Data Abstraction

Public, Private and Protected Building Objects with Classes Defining Operations on Objects

Unit – 4

Inheritance, Derived Classes and Class Hierarchies Multiple Inheritance Name Spaces

Unit – 5

Polymorphism Static & Dynamic Binding Virtual Functions Using Polymorphism

Course outcome :

1. Distinguish between top-down and bottom-up programming approach and apply bottom-up approach to solve real world problems
2. Interpret the difference between static and dynamic binding. Apply both techniques to solve problems
3. Analyse generic data type for the data type independent programming which relate it to reusability.
4. Interpret and design the Exception Handling Techniques for resolving run-time errors and handle large data set using file I/O
5. Analyzing a problem written in English language and apply the methods to code it according to the knowledge provided.

Subject : Object Oriented Programming Lab L T P: 0-0-1.5 Credit : 1.5

Courses objective:

1. The model of object oriented programming: abstract data types, encapsulation, inheritance and polymorphism

2. Fundamental features of an object oriented language like C++: object classes and interfaces, exceptions and libraries of object collections

3. How to take the statement of a business problem and from this determine suitable logic for solving the problem; then be able to proceed to code that logic as a program written in Java.

Course content :
Unit- 1
Introduction
Revision of Important Concepts in C Introduction & Overview From C to C++ Principles of OOP
Unit 2
Classes
Introduction, Operator Overloading, Constructors & Destructors, Predefined C++ Classes in iostream.h, The Copy constructor.
Unit – 3
Data Abstraction
Public, Private and Protected Building Objects with Classes Defining Operations on Objects
Unit – 4
Inheritance, Derived Classes and Class Hierarchies Multiple Inheritance Name Spaces
Unit – 5
Polymorphism Static & Dynamic Binding Virtual Functions Using Polymorphism

Course outcome :
1. Write codes using c++ basic statements
2. Create Class and objects
3. Implement Constructor and Destructors, Polymorphism
4. Write codes for inheritance
5. Use template and analyse a given problem and write codes.

6. Signals and systems L T P: 2-1-0 Credit : 03

Different types of signals: continuous and discrete, impulse sequence, impulse functions and other singularity functions. Types of system: continuous and discrete linearity, time invariance and causality; convolution: convolution sum, convolution integral and their evaluation; time-domain representation and analysis of LTI systems based on convolution and differential equations and difference equation. Multi input-multi output discrete and continuous systems: transform domain considerations: Laplace transforms and Z-transforms; applications of transforms to discrete and continuous systems-analysis; transfer function, block diagram representation. Fourier series and Fourier transform, sampling theorem, discrete Fourier transform (DFT), estimating Fourier transform using DFT. DTFT, DFT, FFT.

Text Books:
1. A.V. Oppenheim, Schafer, R. W,A.S. Willsky and I.T. Young, Signals and Systems, Prentice Hall, 1983
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems - Continuous and Discrete, 4th Edition, Prentice Hall, 1998.

Reference Books:
1. A. Papoulis, Circuits and Systems, Modern Approach, HRW, 1980
2. Kuo, B. C, Automatic Control System, Prentice Hall of India

Courses objective:
1. To introduce students about basic signals and systems in the field of Signals and systems.

2. To understand the different analog and digital systems and their operating principles.

3. To Know about different methods and mathematical tools to analyze signals and systems.

4. To know the industrial practices of signals and systems.

5. To introduce students about specific knowledge to use modern tools necessary for electrical projects.

Course content :

Unit- 1

Different types of signals: continuous and discrete, impulse sequence, impulse functions and other singularity functions.

Unit 2

Types of system: continuous and discrete linearity, time invariance and causality; convolution: convolution sum, convolution integral and their evaluation.

Unit – 3

Time-domain representation and analysis of LTI systems based on convolution and differential equations and difference equation.

Unit – 4

Multi input-multi output discrete and continuous systems: transform domain considerations: Laplace transforms and Z-transforms; applications of transforms to discrete and continuous systems-analysis; transfer function, block diagram representation.

Unit – 5

Fourier series and Fourier transform, sampling theorem, discrete Fourier transform (DFT), estimating Fourier transform using DFT. DTFT, DFT, FFT.

Course outcome:

After successful completion of the course the students will be able to:

1. Acquire mastery in the signals and systems.
2. Able to design analog and digital systems and can do structural analysis over these systems to improve them.
3. Able to understand why digital domain is preferred over analog domain.
4. Able to define the appropriateness of the digital world and its necessity. .
5. Take up projects to apply the learned techniques and skills.
6. About transformations necessary to understand signals and systems completely.

7. Seminar (Soft Skilled Based)

4th Semester

1. Electrical Machine-I L T P: 3-1-1.5 Credit: 5.5

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control.

Text Books:

1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill,1985.
2. S.K.Bhattacharya, *Electrical Machines*, Tata McGraw Hill. 2nd edition,2007.
3. H. Cotton, A.H.Wheeler *,Advanced ElectricalTechnology*
4. V.D Toro, *Electrical Engineering Fundamentals,* 2nd Edition, Prentice-Hall ofIndia.

Reference Books:

1. M G Say, *Performance and Design of AC machines*, CBSPublishers.
2. A.E. Fitzgerald, C. Kingsley Jr. and S. D. Umans, *Electrical Machinery*, McGraw Hill,1983.

Courses objective:

1. To understand the construction and basic principal of operation of electrical machines, and power flow stages.
2. To derive all fundamental operating equations and understanding machines philosophy.
3. To learn the magnetization characteristics, load characteristics, external and internal characteristics of DC machines.
4. To learn the various methods/techniques of starting, speed control and braking of electrical machines.
5. To learn the various techniques of testing of DC & AC machines.
6. To learn the various applications of DC and AC Machines.

Course content:

Unit- 1

Direct Current Generator: principle of operation, construction, description some essential parts, Types of armature windings, Analysis of Lap winding and wave winding along with numerical problems, uses of lap and wave windings. Types of Generator, Derived generated E.M.F equation, total losses in a DC Generator, Power stages, efficiency, condition for maximum efficiency and Numerical problems.

Unit 2

Armature reaction, effects of armature reaction, Methods of reduction of Armature Reaction, Commutation Process, Methods of improving Commutation, Characteristics of DC Generator. Applications

Unit – 3

DC Motor Principle of operation, back emf, voltage equation, Derived Torque equation, Armature torque, DC Motor speed control methods, Torque and speed of a DC Motor, Characteristics of DC Motor, Losses and Efficiency, Power stages, Electric Braking Methods, Starting of DC Motor- two/ three point / four point starter, Testing of DC Motors. Applications

Unit – 4

Induction machine: construction, classification, rotating magnetic field, Induction Motor operating principle, slip, rotor frequency, Relation in between Torque and Rotor power factor, Starting Torque, condition for maximum starting torque, Running torque and its maximum condition, power flow diagram , slip-torque characteristics, effects of change of supply voltage and frequency on torque and speed, Relation in between Torque, Mechanical Power and Rotor Output power, Induction motor as Generalized Transformer, Equivalent circuit of an Induction motor, circle diagram, starting and speed control of induction motor, performance indices, double cage rotor, testing of induction motor, induction generator, crawling and cogging, applications. Applications

Unit – 5

Double-field Revolving Theory, Operating principle of Single Phase Induction Motor, Various types of Single-phase Motor. Applications

Course outcome:

On successful completion of the course, the students will be able to

1. Acquire knowledge about the construction, operation and classification of DC machines.
2. Acquire knowledge about the characteristics and applications of DC machines
3. Understand various losses, power stages, efficiency, speed control techniques, braking techniques and testing of DC machines.
4. Acquire the knowledge about the constructional details and principle of operation of three phase and single phase induction motor.
5. Understand the power flow diagram, slip-torque characteristics and equivalent circuit of induction motor.
6. Acquire knowledge about starting, speed control, testing and applications of induction motor.

Subject: Electrical Machine-II Lab L T P: 0-0-1.5 Credit: 1.5

Courses objective:

1. Study the various types starters and Starting of DC Motors
2. To understand the characteristics DC Motor and DC Generators
3. To determine the efficiency by using different methods.
4. Understanding the various methods of Speed control of DC Shunt Motor.
5. Find out per phase equivalent circuit parameters, losses, by performing O.O.C Teat and S.C Test.
6. Understand the parallel operation and its condition for parallel operation.

Course content:

Unit – 1

Starting of DC Shunt motor with help of three point starter and DC Variac and Speed control of a DC Shunt motor

Unit- 2

Open circuit characteristics i.e. Magnetising characteristics of a DC self-excited / separately excited shunt / compound Generators.

Unit 3

Load characteristics of a DC Shunt / DC compound Generator.

Unit – 4

Determination of efficiency of DC Motor and DC Generator (Swinbure’s test / Hopekinson’s Test)

Unit – 5

Open circuit test and Short circuit test of single phase Transformer,

Unit-6

Parallel operation of two single phase Transformer.

Course outcome:

On successful completion of the course, the students will be able

1. Understand the necessity of starter and distinguish in between three point starter and four point starter.
2. Develop engineering knowledge and practical ability for evaluating the performance of DC machine by determining various characteristics.
3. Understand the fundamental concepts of Speed control DC motors.
4. Understand the methods to get the efficiency of DC machine while run as motor and generator.
5. Understand the technique to get all parameters, losses.
6. Investigate the parallel operation. Understand all necessary conditions for this.

2. Power System-I L T P: 3-1-0 Credit: 4

Idea of different energy resources including renewables, Institutional arrangements & regulatory affairs of power system, Overhead lines and cables: main component of overhead line, line supports, overhead line insulators, insulating materials, types of insulator, corona, underground cable, load curves, power distribution system, primary and secondary distribution. Substations: classification of substations, major equipment in substation, bus bar configurations, line parameter- resistance, conductance, inductance, capacitance of short, medium and long single and three phase lines, proximity effect, skin effect, Ferranti effect, bundle conductors, effect of earth on the capacitance of the conductors, power factor improvement. Performance of lines: A, B, C, D parameters, short, medium, long lines, transmission efficiency, voltage regulation. Per unit system: per unit impedance, changing the base of per unit quantities, pu impedances of transformer, alternator, advantages of per unitsystem, Earthing techniques.

Text Books:

1. W.D. Stevenson, *Elements of Power Systems Analysis*, 4th edition, McGraw Hill,1982.
2. I.J. Nagrath and D.P. Kothari, *Modern Power System Analysis*, Tata McGraw Hill, 2ndEdition, 1989.
3. C.L. Wadha

Reference Books:

1. J Duncan Glover, Mulukutala S. Sarma and Thomas J. Overbye, *Power System Analysis and Design*, Cengage Learning India Pvt. Ltd. 4thEdition.
2. Arthur R burgen and Vijay Vittal, *Power System Analysis*, PearsonEducation.

Courses objective:

To develop comprehensive knowledge and analytical capability of the course attendees on the topics of:

1) Overhead lines and cables, their characteristics and mechanical design
2) Load curves and power distribution system
3) Substations
4) Line parameters and performance of lines including power factor improvement methodologies
5) Per unit system

Course content:

Unit-1

Overhead lines and cables: main component of overhead line, line supports, overhead line insulators, insulating materials, types of insulator, sag and tension, stringing chart, corona, underground cable.

Unit 2

Load curves

Unit 3

power distribution system, primary and secondary distribution.

Unit 4

Substations: classification of substations, major equipment in substation, bus bar configurations

Unit 5

line parameter- resistance, conductance, inductance, capacitance of short, medium and long single and three phase lines, proximity effect, skin effect, Ferranti effect, bundle conductors, effect of earth on the capacitance of the conductors

Unit 6

power factor improvement.

Unit 7

Performance of lines: A, B, C, D parameters, short, medium, long lines, transmission efficiency, voltage regulation.

Unit 8

Per unit system: per unit impedance, changing the base of per unit quantities, pu impedances of transformer, alternator, advantages of per unit system

Course outcome:

On successful completion of the course, the students will be able to

1. Demonstrate an understanding about fundamentals of power system.
2. Have a detailed knowledge about various aspects of overhead lines and underground cables in order to develop analytical and problem solving ability.
3. Have a basic knowledge about substation which in turn may help to solve different problems of substation and design a substation.
4. Gather knowledge about transmission line parameters and analyse the performance of transmission lines in order to solve various related problems.
5. Apply the knowledge gathered about transmission and distribution system to practical scenario such as planning, designing and other practical problems.
6. Demonstrate per unit system and understand its applicability in power system.

3. Data Structures & Algorithm L T P: 2-1-0 Credit: 03

INTRODUCTION: Definition, Interrelationship of Data structure and algorithms, Asymptotic complexity analysis, Abstract Data Types, Recursive programming and recurrence relations ARRAYS: Representation of arrays, Sparse Representation, Circular arrays STACKS AND QUEUES: Fundamental of stacks and queues, Representation with arrays, circular queue, Multiple stacks and queues dynamics, Dequeues.

LINK LISTS: Singly linked list and their manipulation, doubly linked list, storage pool, Dynamic storage management, Garbage collection, generalized list, Linked stacks and queues. TREES: Binary trees and its representation arrays, Tree traversals (preorder, inorder, and postorder), Threaded binary tree, Binary tree representation of tree, heaps, union-findSORTING AND SEARCHING: Searching – linear search, binary search, hashing; Binary search trees, Balanced binary search trees, Different algorithms for sorting – bubble sort, selection sort, insertion sort, merge sort, quicksort, heap sort, radix sort, counting sort, lower bounds for sorting

Recommended Books:

1. S. Lipschutz, "Data Structure" , Schaum's Outline Series, Tata McGraw-Hill
2. Tannenbaum, "Data Structures", PHI
3. An Introduction To Data Structures With Applications, Tremblay J.P. and Sorenson P.J, Tata Mcgraw Hill
4. 'Fundamentals of Data Structures', Horowitz S. and Sahani S., Computer Science Press.

4. Numerical Methods and Analysis L T P: 3-1-1 Credit : 05

Solution to algebraic and transcendental equations by regula-falsi method, iteration method, Newton-Raphson method, simultaneous linear algebraic equations by Gauss-Jordon method, Crout's method, factorization method, Gauss-Seidel iterative method, determination of eigen values. Numerical differentiation based on interpolation, numerical integration, a general quadrature formula for equidistant ordinates, the trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Weddles rule, Method of undetermined coefficients, extrapolation method. Numerical solution of ordinary differential equations of first order by Euler's and Runge –Kutta's method.Introduction to interpolation, interpolation with equal intervals, different interpolation methods (Newton-Gregory forward and backward difference formulae), interpolation with unequal intervals,divided differences and table, Newton's divided difference formulae, central difference interpolation formulae (Gauss, Stirling, Bessel formulae), piecewise and spline interpolation, (cubic splines) least squaresapproximations.

Text Books:

1. Robert J. Schiling and Sandra L. Harris, *Applied Numerical Methods for Engineers using Matlab and C*, Thomsom Asea Pte.Ltd.
2. S.S. Sastry , *Introductory methods of numerical analysis*, 4thedition, PHI Learning Pvt. Ltd., 2005

Reference Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 9th edition, Wileypublication
2. S. A. Mollah, *Numerical methods*, T.M.H.publication

Courses objective:

1. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration and also to improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.

2. The objectives of studying this course are to make the students familiarise with the ways of solving complicated mathematical problems numerically which cannot be easily solved by analytical method.

3. Influence of data representation and computer architectures on algorithms choice and development.
4. The limitations of analytical methods for the solution of algebraic and transcendental equations have necessitated the use of iterative methods in numerical analysis.
5. The main aim of studying curve fitting is to find a curve that could best indicate the trend of a given set of data whereas interpolation is to connect discrete data points so that one can get reasonable estimates of data points between the given points.

Course content:

Unit- 1

Interpolation: Different interpolation methods (Newton-Gregory forward and backward difference formulae), interpolation with unequal intervals, divided differences and table, Newton's divided difference formulae, central difference interpolation formulae (Gauss, Stirling, Bessel formulae), piecewise and spline interpolation, (cubic splines) least squares approximations.

Unit- 2

Solution of algebraic and transcendental equations: Solution to algebraic and transcendental equations by regula-falsi method, iteration method, Newton-Raphson method.

Unit- 3

Numerical differentiation and numerical integration: Numerical differentiation based on interpolation, numerical integration, a general quadrature formula for equidistant ordinates, the trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Weddles rule, Method of undetermined coefficients, extrapolation method. Introduction to interpolation, interpolation with equal intervals,

Unit 4

Solution of simultaneous equations: Simultaneous linear algebraic equations by Gauss-Jordon method, Crout's method, factorization method, Gauss-Seidel iterative method, determination of eigen values.

Unit – 5

Numerical Solution of Ordinary differential equation: Numerical solution of ordinary differential equations of first order by Euler's and Runge –Kutta's method.

Course outcome:

1. A particular and important aspect in the numerical methods subject is the approximation of the different values, operation designated as interpolation, which is employed in most of the branches of the engineering.
2. Numerical differentiation and integration is the process of computing the value of the derivative of a function, whose analytical expression is not available, but is specified through a set of values at certain tabular points.
3. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
4. Most problems arising from engineering and applied sciences required the solution of systems of linear algebraic equations and computations of eigen values and eigen vectors of a matrix. Numerical analysis helps to solve such type of equations in a easier manner. The eigen values of a matrix are of great importance in many engineering problems for example, problem concerning the stability of an aircraft and those on vibration of a beam require the computation of eigen values of a matrix.
5. There exist a large number of ordinary differential equations whose solution cannot be obtained in closed form by using the well known analytical method, where the use of numerical methods gets the appropriate solution of a differential equation under the prescribed initial condition or conditions.

5. Analog Electronics L T P: 3-1-1 Credit: 05

Operation and characteristics of BJT and FET, Biasing circuits. Frequency response of different configurations. h-parameter model of BJT. Power amplifiers. Feedback amplifiers. Differential amplifiers. Tuned amplifiers. Simple active filters. Op-amp, ideal and non-ideal properties, high frequency effects on op-amp gain and phase. Linear and non-linear circuit applications of op-amp. Various Oscillators. Voltage regulators. VCOs and timers.

Text Books:

1. J. Millman and A. Grabel,, *Microelectronics*, McGraw Hill, International,1987.
2. J. Millman and C. C. Halkias., *Electronic Devices and Circuits*, McGraw-Hill, NewYork.

Reference Books:

1. A.S. Sedra and K.C. Smith, *Microelectronic Circuits*, Saunder's College Publishing,1991
2. R. *Boylestad* and L. Nashelsky, *Electronic Devices and Circuit Theory,* Prentice Hall PublishingCo.
3. L.S. Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press.

Courses objective:

1. Observe the effect of negative feedback on different parameters of an Amplifier and different types of negative feedback topologies.
2. To analyse the different RC and LC oscillator circuits to determine the frequency of oscillation.
3. To understand the operation of the various bias circuits of BJT and FET and Analyze and design bias circuits.
4. Acquire basic knowledge of physical and electrical conducting properties of semiconductors.

5. Develop the Ability to understand the design and working of BJT / FET amplifiers and linear non linear opamp circuits.

6. To design amplifier circuits using BJT s And FET's. and observe the amplitude and frequency responses of common amplifier circuits.

7. Observe the effect of positive feedback and able to design and working of different Oscillators using BJTS.

8. Develop the skill to build, and troubleshoot Analog circuits.

Course Content:

Unit- 1Review of Semiconductors
Semiconductor diode VI characteristics, Diode numerical problems.
Unit 2 Bipolar Junction Transistors (BJTs)
Transistor characteristics, analysis and design of different biasing circuits, h-parameter model of BJT, mid frequency and low frequency analysis of CE, CB and CC amplifier, hybrid-pi model of BJT, high frequency analysis of BJT amplifiers, transistors as a switch; transient switching characteristics of transistors.
Unit – 3 Field Effect Transistors (FETs)
Analysis and design of different biasing circuits of FET amplifiers, small-signal low frequency model of FET, mid frequency and low frequency analysis of CS, CG and CD amplifiers, small-signal high frequency model of BJT, high frequency analysis of FET amplifiers, bode plots.
Unit – 4General theory of feedback
Stability of feedback amplifier, different feedback topologies, effect of different parameters of an amplifier, frequency response of 2pole/3 pole feedback amplifiers, bode plot, gain and phase margin, compensation, method analysis, design examples.
Unit – 5Amplifiers
Differential amplifiers using BJT and FET characteristics of op-amp, ideal and non ideal properties, high frequency effects on op-amp gain and phase, bode plot slew rate limitation.
Unit – 6Linear and non-linear circuit applications of Operational Amplifiers
Analysis of op-amp circuit, integrator, differentiator ,comparators, Schimitt trigger (inv and non-inv), triggerable and non-triggerable multi-vibrator, triangular and sinusoidal wave generators, precision rectifier, gyrator network, frequency dependent negative resistance (FDNR), peak detector.
Unit – 7 Oscillators and Voltage Regulators
Wein bridge oscillator, phase shift oscillator, quadrature oscillator, harmonic oscillators, tuned oscillator, Colpits oscillator, Hartely oscillator. Design of series voltage regulator, series regulator with current pre-regulator.

Course outcome:

At the end of the course students will have the ability to:

1. Define significance of Semiconductor diode, BJT, FET, Op Amps and their importance.
2. Effect of feedback and other feedback topologies. Ability to use OP Amp in various linear nonlinear circuits.
3. In-depth knowledge of applying the concepts of BJTs and FETs in real time applications also by building circuits.

<u>Subject: Analog Electronics Lab L T P: 0-0-1 Credit: 1</u>

Courses objective:

1. To provide experience on design, testing and analysis of few op amp circuits such as

   Inverting amplifier, non-inverting amplifier, Summing and difference amplifier, Instrumentation Amplifier.

2. To provide experience on design, testing and analysis of Integrator and Differentiator.

3. To provide experience on design, testing and analysis of few electronic circuits such as

   Astable and monostable multivibrators. Determine the frequency of oscillation.

4. To provide experience on design and testing of Schmitt trigger.

5. To develop the skill to build, and troubleshoot Analog circuits.

Course Content:

Unit- 1
To sketch and analyse the following basic op-amp circuits and explain the operation of each Unity gain amplifier (With DC and AC Power supply), Inverting amplifier (With DC and AC Power supply), Non-Inverting amplifier (With DC and AC Power supply) with transfer characteristics, slew rate, gain and wave form analysis. To trouble shoot and analyze faults in the op-amp circuits
Unit 2
To introduce the design and characteristics of Summing amplifier and Difference amplifier. Observe the input voltages and output voltage, find the magnitude of the output voltage and tabulate the reading. Compare the experimental results with the theoretical values. To trouble shoot and analyze faults in the summer or difference amp circuits.
Unit – 3
To introduce the design characteristics of Instrumentation amplifier. Observe the input voltages and output voltage, find the gain with variable resistance and tabulate the reading. Compare the experimental results with the theoretical values.
Unit – 4
To design and setup a Inverting and Non- Inverting Schmitt trigger, plot the input output waveforms and measure V_{UT} and $V_{LT}$with its hysteresis characteristics.
Unit – 5
To introduce the characteristics of Integrator and Differentiator amplifier. Observe the input and output voltages on a CRO. Determine the gain of the circuit and tabulate the readings. Draw the waveforms.
Unit – 6
To design and setup the Regenerative feedback system with Astable Multivibrator and Monostable Multivibrator, plot the waveforms and measure the frequency of oscillation.

Course outcome:
At the end of the course students will have the ability to:
1. Observe the effect of feedback on Op Amps in both dc and ac circuits.
2. Design Op-amp circuits to perform arithmetic operations.
3. Analyze and design oscillators using Op-amps.

6. Elective-I

7. Seminar (Soft Skilled Based)

Elective-I

1. Applied Thermodynamics L T P: 3-0-0 Credit: 03

Definition: Thermodynamic system, control volume, thermodynamic properties, processes, cycles, homogenous and heterogeneous system, thermodynamic equilibrium, quasi-static process, work transfer, pdv work, indicator diagram, free expansion, path function. First law of thermodynamics: quantity of energy and its measurement, first law energy equation for closed and open loop system under SSSF and USUF condition, application of first law energy equation to thermodynamic system components such as boiler, turbine, compressor, nozzle, expander, pump, condenser, first law efficiency, first law analysis of combustion process. Second law of thermodynamics, quality of energy and its measurements, reversible and irreversible processes, entropy and its significance, principle of increase of entropy of the universe, Carnot cycle, Clausius inequality, application of second law to various thermodynamic system, combination of first and second law, first and second law combined, reversible adiabatic work in a steady flow system, unsteady flow, control system analysis, control volume analysis, entropy and disorder, availability and irreversibility, second law analysis of combustion process, air standard cycles, Otto-cycle, Diesel cycle, limited pressure cycle, comparison of Otto and Diesel and dual cycle, Brayton cycle, Stirling cycle and Ericsson cycle. Simple vapour cycles, Rankine cycle, actual vapour cycle processes, comparison of Rankine and Carnot cycle, reheat cycle, regenerative cycle, binary vapour cycles

Text/Reference Books :-

1. Nag, P.K., *Engineering Thermodynamics*, 3rd edition, Tata McGraw-Hill,2005
2. Cengal,Y.AandBoles,M.A,*Thermodynamics:AnEngineeringApproach*,5thedition,McGrawHill,2006.
3. Rajput, R.K.,*ThermalEngineering*
4. Ballaney, P.L,*Thermal Engineering*, KhannaPublishers

Courses objective:

1. To cover the basic principles of classical thermodynamics in a comprehensive way inconsistent with engineering perspective
2. To develop an intuitive understanding of thermodynamics by insightful explanation of the physics and physical arguments
3. To lay the foundation of subsequent subjects like Applied Thermodynamics, Fluid Mechanics, Heat and Mass Transfer, Refrigeration, Air Conditioning etc.
4. To prepare the students efficiently how to use classical thermodynamics in practical engineering applications

Course content:

Unit – I:
Definition: Thermodynamic system, control volume, thermodynamic properties, processes, cycles, homogenous and heterogeneous system, thermodynamic equilibrium, quasi-static process, work transfer, pdv work, indicator diagram, free expansion, path function.

Unit – II:
First law of thermodynamics: quantity of energy and its measurement, first law energy equation for closed and open loop system under SSSF and USUF condition, application of first law energy equation to thermodynamic system components such as boiler, turbine, compressor, nozzle, expander, pump, condenser, first law efficiency, first law analysis of combustion process.

Unit – III:
Second law of thermodynamics, quality of energy and its measurements, reversible and irreversible processes, entropy and its significance, principle of increase of entropy of the universe, Carnot cycle, Clausius inequality, Application of second law to various thermodynamic system, combination of first and second law, first and second law combined, reversible adiabatic work in a steady flow system, unsteady flow, control system analysis, control volume analysis, Entropy and disorder, availability and irreversibility, second law analysis of combustion process.

Unit – IV:

Air standard cycles, Otto-cycle, Diesel cycle, Limited pressure cycle, comparison of Otto and Diesel and dual cycle, Brayton cycle, Stirling cycle and Ericsson cycle.

Unit – V:

Simple vapour cycles, Rankine cycle, Actual vapour cycle processes, comparison of Rankine and Carnot cycle, Reheat cycle, regenerative cycle, binary vapour cycles**.**

Course outcome:

After going through careful explanations of concepts, numerous practical examples and figures, a student will be able to

1. Understand the basic principles of thermodynamics
2. Use the necessary skills to bridge the gap between knowledge and the confidence to properly apply knowledge
3. Understand the interrelation between the thermodynamics functions
4. Know how energy transformation takes place
5. Gain the knowledge to use such relationships to solve the real-world engineering applications
6. Understand the most complex problems, formulate them, and interpret the results.

2. <u>Fluid Mechanics</u>

Properties of fluid: Mass and weight density, specific gravity, specific volume, viscosity and Newton's law of viscosity, compressibility, types of fluid, surface tension and capillarity, pressure and its measurement: fluid pressure at a point and pascal's law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement-manometers and mechanical gauges. Hydrostatics: Total pressure and centre of pressure for horizontal, vertical, inclined plane surfaces and curved surfaces submerged in liquid. Total pressure and centre of pressure on lock gates. Buoyancy and flotation: Buoyancy, centre of buoyancy, iamagneti and metacentric height and equilibrium of floating bodies, period of oscillation .Kinematics of flow: Types of fluid flow, continuity equation in three dimensions, velocity potential function and stream function, forced and free vortex flow. Dynamics of flow: Euler's equation and Bernoulli's equation , application of Bernoulli's equation-venturimeter, orifice-meter, and pitot tube. Orifice and notches: Flow through orifices, hydraulic coefficients, time of emptying hemispherical and horizontal cylindrical tank through an orifice at it's bottom, discharge over rectangular, triangular and trapezoidal notches, velocity of approach. Laminar flow : Flow of viscous fluid through circular pipe-velocity distribution and average velocity, Hagen Poiseiulle formula, kinetic energy correction and momentum correction factors , Navier-Stokes equation of motion. Turbulent Flow: Reynold's experiment, Loss of head due to friction in pipes, Reynold's expression and Prandtl mixing length theory for turbulent shear stress. Flow through Pipes: Major and minor losses of energies in pipes,

hydraulic gradient and total energy lines, flow through pipes in series, equivalent pipe, flow through parallel pipes, power transmission through pipes and nozzles, water hammer.

<u>Text/Reference Books :-</u>

1. Bansal, S.K., *Fluid Mechanics & Hydraulic Machines*, Laxmi Publications.
2. Cengel, Y.A., *Fluid Mechanics: Fundamentals & Applications (SI Units)*, Tata McGraw- Hill Publications
3. Jain, A.K., *Fluid Mechanics*, Khanna Publishers.
4. Rajput, R.K., *Fluid mechanics & Hydraulic machines* , S. Chand Publications.

3. <u>Strength of Materials</u>

Stress, strain, types of stresses, elastic limit, Hook's law, Analysis of bars of varying sections, law of superposition, composite bar, thermal stress, thermal stresses in composite bars, elongation of bar due to it's own weight, stress-strain diagram. Introduction , longitudinal & lateral strain, Poisson's ratio, volumetric strain for rectangular bar, bulk modulus , principle of complementary shear stress, relation between various elastic constants. Principle planes and principle stresses, methods for determining stresses on oblique section, analytical method, graphical method, Mohr's circle, use of Mohr's circle to find principle stresses. Types of beams and loads, S.F & BM diagram for a cantilever, uniformly distributed load, simply supported beam for various types of loading, relation between load, shear force and bending moment diagram. Theory of simple bending, expression for bending stress, bending stresses in symmetrical sections, section modulus, section modulus for various shapes of beam sections, bending stress in unsymmetrical sections, deflection of various types of beams. Basic assumptions and derivation of shear stress produced in a circular shaft subjected to torsion, torque transmitted by a circular and hollow circular shaft, polar modulus, strength of a shaft and tensional rigidity, composite shafts, combined bending and torsion, strength of a shaft of varying crosssection.

Text/Reference Books :-

1. Ramamurtham, S., "Strength of Materials", Dhanpat Rai & Sons,1974.
2. Bansal, R.K., "*Strength of Materials",* Laxmi publications.
3. Beer, Johnston., "*Mechanics of Materials"*, Tata McGraw-HillPublications

4. Electrical Engineering Materials L T P: 3-0-0 Credit: 03

Crystallography: Crystalline and amorphous solids, periodic structures – Lattice, basis, unit cell, bravais lattice, crystal structure and symbols, millar indices reciprocal lattice. X- ray crystallography: X- ray diffraction , Bragg's law , determination of lattice constant, atomic form factor, closest packing of spheres, packing efficiency , crystal defects, band theory of solids, Kronig – Penny model, Brillouin zones, electronic distinction between conductors , insulators and semiconductors, dielectric properties of materials: iamagnetism and dielectric constant, frequency and temperature dependence of relative permittivity iamagne of dielectric under alternating fields, dielectric losses. Conductors: Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering, resistivities of conductors including alloys. Semiconductors: Intrinsic and Extrinsic semiconductors, Fermi-Dirac distribution, dependence of carrier concentration on temperature, measurement of resistivity, four probe method, Hall effect, measurement of carrier concentration, Zener breakdown phenomenon, photo-electric effect in semiconductors. Magnetic properties of materials: iamagnetism, paramagnatism, ferromagnetism, exchange interaction, antiferromagnatism, ferrimagnetism, and ferrites, magnetic resonance, magnetotriction , Curie-Weiss law , Curie law, Curie temperature of ferromagnetic material, soft and hard magnetic material. Ni-Fe alloy and applications, Alnic, Alcomax and application. Special materials, ceramics, polymers, XLPE, nanostructures and nanomaterials, biomaterials and bioceramics. Superconductivity: Superconductivity phenomena, meissner effect, type I and type II, superconductors, high TC Superconductors, Josephson junction,SQUID.

Text/Reference Books :-

1. A.J. Dekker, *Solid State Physics*, Tata McGraw-HillPublications
2. C. Kittel, *Introduction to Solid State Physics*, Wiley &sons
3. R L Singhal , *Solid State Physics,* Macmillan *Publishing* Co.
4. S.O. Pillai ,*Solid State Physics*, McGraw HillPublisher**Courses objective:**

1. To provide the knowledge of science to understand the solution of complex engineering problems.
2. To know basic theory to Identify, formulate, and analyze complex engineering problems reaching substantiated conclusions using engineering sciences.
3. To provide basic theories of materials to understand their technological applications.
4. To provide idea about applications of materials in technology.

Course content :

Unit- 1

Crystallography : Crystalline and amorphous solids. Periodic structures – Lattice, Basis , Unit cell. Bravais lattice , Crystal structure and symbols , Millar Indices Reciprocal lattice

Unit-2

X- ray Crystallography : X- ray diffraction , Bragg,s law , Determination of lattice constant. Atomic form factor, Closest packing of spheres, packing efficiency , crystal defects

Unit – 3

Band theory of solids : Kronig – Penny Model, Brillouin Zones. Electronic distinction between conductors , insulators and semiconductors.

Unit – 4

Dielectric properties of materials : Polarisation and dielectric constant, Frequency and temperature dependence of relative permittivity behavior of dielectric under alternating fields, dielectric losses

Unit – 5

Conductors : Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering, Resistivities of conductors including alloys

Unit – 6

Semiconductors : Intrinsic and extrinsic semiconductors, Fermi-Dirac distribution, dependence of carrier concentration on temperature, Measurement of resistivity, Four probe method, Hall effect, measurement of carrier concentration , Zener breakdown phenomenon, Photo-electric effect in semiconductors.

Unit – 7

Magnetic properties of materials : Diamagnatism, paramagnatism, ferromagnatism. Exchange interaction, antiferromagnatism, ferrimagnetism, and ferrites. Magnetic resonance, Magnetotriction , Curie-Weiss law , Curie law, Curie temperature of ferromagnetic material. Soft and Hard magnetic material .Ni-Fe alloy and applications, Alnic, Alcomax and application.

Unit – 8

Special materials : Ceramics, polymers , XLPE, nanostructures and nanomaterials Biomaterials and bioceramics.

Unit – 9

Superconductivity : Superconductivity phenomena, Meissner effect, Type 1 and Type 11 superconductors, High TC Superconductors, Josephson junction. SQUID

Course outcome:

1. Helps to understand the basic properties of materials
2. Helps to understand the theories behind the properties of material.
3. Helps to understand application of materials in technology.

5th Semester

1. Electrical Machine-II L T P: 3-1-1.5 Credit: 5.5

Synchronous machine: construction, classification, application, non-salient pole synchronous machine: working principle, emf equation, distribution factor and pitch factor, armature reaction, equivalent circuit, phasor diagram, calculation of synchronous reactance, performance indices, isolated and parallel operation of synchronous generator, power angle characteristics, V-curve , load sharing, starting of synchronous motor, hunting, short circuit transient in synchronous machine. Salient pole synchronous machine: two reaction theory, determination of X_d and X_q, performance. Single phase motor: classification of single phase motor and their applications, single phase induction motor- double revolving field theory, equivalent circuit, torque- slip characteristics, performance.

Text Books:

1. I. J. Nagrath and D. P. Kothari, *Electric Machines*, Tata McGraw Hill,1985.
2. E. Fitzgerald, C. Kingsley Jr. and S. D. Umars, *Electrical Machinery*, McGraw Hill,1983.

Reference Books:

1. M G Say, *Performance and Design of AC machines*, CBS Publishers.
2. A.F Puschtein & T.C. Lloyd, *Alternating Current Machines*, John Wiley &Sons.

Courses objective:

1. To understand the construction and basic principal of operation of synchronous machine, Single phase induction machine single phase synchronous motor, single phase commutator motors and other special machines
2. To understand and apply different method for experimental determination of synchronous reactance of salient and non salient synchronous machine
3. To develop analytical skills for evaluating performance parameter such as voltage regulation, efficiency, power factor etc.
4. To understand the basic concepts of parallel operation in a synchronous generator and mathematically analysis the phenomenon of load sharing between synchronous generator connected in parallel
5. Basic understanding of and transients phenomena's such a starting, hunting, faults in a synchronous machine.
6. Performance analysis of single phase induction machine

Course content:

Unit- 1

Construction, classification, basic principal of operation and application of synchronous machine

Unit 2

EMF equation, distribution factor and pitch factor armature reaction, equivalent circuit, phasor diagram, calculation of synchronous reactance, performance indices

Unit – 3

Isolated and parallel operation of synchronous generator, power angle characteristics, V-curve , load sharing

Unit – 4

starting of synchronous motor, hunting, short circuit transient in synchronous machine

Unit – 5

Salient pole synchronous generator-two reaction theory, phasor diagram, performance analysis determination of Xd and Xq

Unit – 6

Single phase motor: classification of single phase motor and their applications,
Unit – 7
single phase induction motordouble revolving field theory, equivalent circuit, torque- slip characteristics, performance calculations
Unit – 8
Principal of operation of single phase synchronous motor, single phase commutator motors .

Course outcome:

On successful completion of the course, the students will be able

1. To understand basic principal of operation of synchronous machine, Single phase induction machine single phase synchronous motor, single phase commutator motors and other special machines
2. To experimentally determine the value of synchronous reactance of salient and non salient synchronous machine
3. To calculate performance parameter such as voltage regulation, efficiency, power factor etc. of synchronous machine.
4. To understand the basic concepts of parallel operation in a synchronous generator and calculate load sharing between synchronous generators connected in parallel
5. Develop basic understanding of and transients phenomena's such a starting, hunting, faults in a synchronous machine.
6. To determine the equivalent circuit parameter of single phase induction machine and evaluate the performance parameter from the equivalent circuit.

Subject:Electrical Machines -II Lab L T P: 0-0-1.5 Credit: 1.5

Courses objective:

1. Study the fundamental concepts and principles of operation of three phase Alternator and Induction motor.
2. Understanding the magnetizing characteristics of AC Generator
3. Understanding the phenomena like voltage regulation of an three phase Alternator, variation field current over the armature current and power factor of a three phase synchronous motor.
4. Learn the experimental method to measure the parameters like synchronous Impedance, reactance etc.
5. Study various starters or starting methods of three phase Induction motor, speed control methods. Learn the techniques to determine the machine parameters in order to develop the mathematical model of three phase Induction motor.
6. To perform the parallel operation of Alternators and understanding load sharing.

Course content:

Unit- 1
Determination of the magnetization characteristics of Synchronous Generator (Alternator)
Unit 2
To determine the voltage regulation of three phase Alternator by Synchronous Impedance method.
Unit – 3
To study the effect of variation of field current upon stator current and power factor of a Synchronous at various loads, draw "V" curve and inverted "V" curve.
Unit – 4
To measure the direct axis synchronous reactance and quadrature axis reactance by Slip test of a Synchronous machine.
Unit – 5

Study the starters for three phase Induction Motor.

Unit – 6

Perform No load Test and Blocked Test.

Unit – 7

To study speed control of a three phase Induction motor.

Unit – 8

Parallel operations three phase Alternators.

Course outcome:

On successful completion of the course, the students will be able to

1. Develop engineering knowledge and practical ability for evaluating the performance of AC machine by determining various characteristics.
2. Understand the necessity of starter and know about various types starters for AC motors.
3. Develop the basic experimental and modelling skills for handling problems associated with electrical AC machines
4. Develop practical skill for evaluating various performances of a AC machine such as speed control, Load characteristics of a Three phase Induction motor, Magnetization characteristics, Load characteristics, of a Synchronous Generator, variation of field excitation current over the armature current and power factor for a three phase synchronous motor.

2. Power Electronics L T P: 3-1-1.5 Credit: 5.5

Characteristics of power semiconductor switches: diodes, SCR, MOSFET and IGBT; their driving and switching aid circuits and cooling issues; Uncontrolled Rectifiers: single phase and three phase operation. Phase controlled rectifier- single-phase & three- phase converters, effects of source inductance, dual converters, issues of line current harmonics and power factor; cyclo-converter. Principles of switched mode dc to ac conversion: single-phase and three phase voltage source inverters and current source inverter. Various PWM techniques: SPWM, SVPWM. Basic principles of switched mode dc-dc power conversion: non-isolated and isolated converter-fly back, forward and push-pull.

Text Books:

1. Muhammad H Rashid, Power Electronics Circuits Devices and Applications.
2. N. Mohan, T. M. Undeland, W. P Robbins, *Power Electronics: Converter, Applications & Design*, 3rd edition, Wiley &Sons.
3. L. Umanand, *Power Electronics*, Wiley India Pvt.Ltd.

Reference Books:

1. B. W. Williams, *Power Electronics: Devices, Drivers and Applications*, Macmillan,London

Courses objective:

1. To understand the construction and basic principal of operation of various types of power semiconductor devices in order have knowledge where to apply those particular devices in line with field of application.
2. To understand and analyze different types of converters like uncontrolled rectifier, ac-dc, dc-dc, dc-ac, ac-ac
3. To understand, analyze and develop the driver circuits, snubber circuits, heat sink etc.
4. To understand and analyze switch mode power supply, uninterrupted power supply and their application.

5. To develop analytical skills for evaluating performance parameters such as power delivered to load, input VA rating, input power factor, ripple factor, efficiency etc. for different converters.

6. To understand the basic concepts of developing driver circuits, control circuits and power circuits which are the basic components of any power electronic systems.

Course content:

Unit-1
General introduction of power electronics, scope and applications
Unit-2
Review of power semiconductor devices, their protection, heat management and drive circuits. Switching losses and snubber.
Unit-3
Diode rectifiers and operating characteristics.
Unit-4
Principles of phase angle control- single-phase & three phase semi-converters and full converters. Inverter operation, effects of source inductance, dual converters.
Unit-5
Single stage ac to ac conversion: single-phase and three-phase ac voltage controllers, cyclo-converters.
Unit-6
Principles of switched mode dc to ac conversion: single-phase and three phase voltage source inverters; modes of operation, voltage control and waveform control. PWM principles, current source inverters.
Unit-7
Choppers: principle of operation & modes of operation. Basic principles of switched mode dc-dc power conversion- isolated and non isolated converter configurations.

Course outcome:

On successful completion of the course, the students will be able

1. To have a basic idea about the construction and operation of different power semiconductor switches like SCR, MOSFET, IGBT, GTO etc.

2. To understand and analyze the performance of uncontrolled rectifiers.

3. To understand and analyze the performance of controlled rectifiers, inverters, choppers, cyclo-converters and ac voltage controllers for their application in different filed –like chopper and rectifiers in DC drives, inverters in AC drives etc.

4. To understand, analyze and develop the driver circuit and snubber circuits etc for turning the different switches.

5. To understand, analyze apply the switch mode power supply, uninterrupted power supply in specific application.

6. To develop analytical skills understanding for evaluating performance parameters such as power delivered to load, input VA rating, input power factor, ripple factor, THD, efficiency etc for different converters.

Subject: Power Electronics Lab LTP: 0- 0- 1.5 Credit : 1.5

Course objective:

1. To provide working experience with the power electronics concepts presented in the lecture course, while giving students knowledge of the special measurement and design techniques.

2. To design/select components required for specific power supply application and study the performance.

3. To familiarize students with basic features of laboratory equipment like multi meter, power supplies, oscilloscopes and function generators.

4. Design basic circuits using general purpose PCB / printed circuit boards.
5. Students will learn to work in a team thus developing professional ethics and responsibilities.

Course content:

1. Diode Rectifier with LC Filter AC side Inductor 0-15-30mH.

2. Diode Rectifier with LC Filter DC side Inductive filter & DC side Capacitor 0-180-360mH.

3. Diode Rectifier with LC Filter DC side Inductive filter & DC side Capacitor 0-30-60mH.

4. Fully Controlled Rectifier with Inductive Load 0 - 180 - 360mH CCM Operation.

5. R- Triggering of SCR.

6. RC half Triggering of SCR.

7. RC full Triggering of SCR.

8. PCB Designing from a given circuit.

Course outcome:

After successful completion of the course students will be able to

1. Keep technical records of experiments carried out and use basic features of laboratory equipment like multi meter, power supplies, oscilloscopes and function generators.

2. Understand and analyze the performance of controlled converter.

3. Understand and analyze the performance of uncontrolled converter.

4. Designing , analyzing and development of SCR triggering circuits

5. Demonstrate participation activities that develop their personal generic capabilities e.g. Interpersonal relationship skills, high standard of ethical behavior, teamwork etc.

2. <u>Microprocessors and Microcontrollers L T P: 3-0-1 Credit: 04</u>

Block diagram view of a general purpose processor (Preferably 8085 or 8086): Elements of hardware and software architectures; introduction to concepts of data and control paths, registers and memory organization. Instruction set basics and assembly language programming: instruction structure and addressing modes, instruction encodingtiming diagrams, internal registers, interrupt mechanism (hardware/software). DMA mechanism - Detailed description of a typical microprocessor. Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC, instruction cycle, machine cycle, T states. Instruction set, addressing modes, stack subroutine, and interrupt service routines.
8051 hardware and instruction set architecture, timers/counters, interrupts and serial interface (including multi-processor communication). Interfacing basics using examples of I/O devices: parallel port, serial ports, keypad, display, etc.
Introduction to PIC micro controllers -Advantage of PIC micro controllers – History, Types and products of PIC and features, CCS C Compiler and PIC18F Development System, PIC Architecture & Programming, PIC I/O Port Programming, PIC Programming in C, PIC18 Hardware Connection and ROM loaders, PIC18 Timers

Programming, PIC18 Serial Port Programming, Interrupt Programming, LCD and Keypad Interface, External EEPROM and I2C, USB and HID Class, ADC and DAC, Sensor and other Applications, CCP and ECCP Programming.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085A/8080A, Wiley EasternLimited.
2. Muhammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Inc., Fifth Edition,2003.

Reference Books:

1. I. Liu, G. A. Gibson, Microcomputer Systems: The 8086/8088 Family, 2nd Ed., Prentice Hall,1986.
2. Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill,1991
3. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996

Courses objective:

1. Introduction to different types of microprocessor and microcontrollers including Intel 8085, 8086 and 8051.
2. The architecture, pin configurations, address and data lines, different types of registers.
3. Instruction cycle, machine cycle, T states, instruction set, addressing modes, stack subroutine; interrupt service routines, Opcode fetching, execution and timing cycle and machine cycle.
4. Assembly level language programming for microprocessor and microcontrollers.
5. Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC.
6. Development of application programs in assembly language using 8051. I/O interfacing standards. Microprocessor based system design aids and troubleshooting techniques.

Course content:

Unit- 1

Microprocessor architecture- address / data and control lines, timing diagrams, internal registers, interrupt mechanism (hardware/software)

Unit - 2

DMA mechanism- study mainly based on Intel 8085 and other popular microprocessors.Detailed description of a typical microprocessor (preferably 8085 & 8086).

Unit – 3

Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC.

Unit – 4

Assembly language programming of 8 bit and 16 bit microprocessors : instruction cycle, machine cycle, T states. Instruction set, addressing modes, stack subroutine, interrupt service routines. Example programs in assembly languages. Concept and operation of assembler and cross assembler.

Unit – 5

Microcontrollers and embedded processors- difference between a microprocessor and microcontroller criteria for choosing a microcontroller. Architecture, memory interface and programming concepts of some microcontrollers including 8051.

Unit – 6

Development of application programs in assembly language using 8051. I/O interfacing standards. Microprocessor based system design aids and troubleshooting techniques.

Course outcome:

1. Introduction to Intel 8085 microprocessor architecture- address / data and control lines, timing diagrams, internal registers. Introduction to Operating Systems, Real Time Operating Systems, Device Drivers.

2. Familiar with interrupt mechanism Interfacing and control - Analog I/O, Digital I/O, Bus I/O, Serial and Network I/O, Memory, Power and Display Devices

3. Students get familiar with cycle, machine cycle, T states, instruction set, addressing modes, stack subroutine; interrupt service routines, Opcode fetching, execution and timing cycle and machine cycle.

4. Students learn to do assembly level language programming with different instructions for data transfer, arithmetic and logical operations, subroutine etc.

5. Students learn about Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display, ADC/DAC.

6. They study about development of application programs in assembly language using 8051. I/O interfacing standards. Microprocessor based system design aids and troubleshooting techniques.

Subject: Microprocessors and Microcontrollers Lab L T P: 0-0-1 Credit: 01

Courses objective:

1. To learn about different types of microprocessor and microcontrollers including Intel 8085, and 8086 etc. and to learn basics of Assembly Language Programming.

2. To learn logical and advanced instructions and to use them in Assembly Language Programming

3. To learn interfacing with support chips, signals and timing details along with hardware/software interfacing techniques. I/O interfaces with switch, multi-segment display etc.

4. To develop application programs in assembly language; to learn I/O interfacing standards, Microprocessor based system design aids and troubleshooting techniques.

Course content:

Unit- 1
Microprocessor architecture- address / data and control lines, timing diagrams, internal registers, interrupt mechanism (hardware/software). Microcontrollers and embedded processors- difference between a microprocessor and microcontroller, criteria for choosing a microcontroller. Assembly language programming of 8 bit and 16 bit microprocessors
Unit - 2
Instruction set, addressing modes, stack, subroutine, and interrupt service routines. Example programs in assembly languages on a typical microprocessor (preferably 8085).
Unit – 3
Interfacing with support chips, signals and timing details along with hardware/software interfacing techniques.
Unit – 4
Development of application programs in assembly language. I/O interfacing standards. Microprocessor based system design aids and troubleshooting techniques.

Course outcome:

After successful completion of the course the students will be able to:
1. Demonstrate an understanding of the fundamentals of microprocessor and microcontroller, difference between them; write basic Assembly Language Program.
2. Use logical and advanced instructions in different types of Assembly Language Program.

3. Understand interfacing with peripherals, signals and timing details along with hardware/software, I/O interfacing techniques.
4. Design various Microprocessor and microcontroller based application programs.

4. Control System-I L T P: 3-1-1 Credit : 05

Introduction: Control systems, Physical elements of a control system, classification, examples, effects of feedback, concept of non-linearity.

Mathematical Model of Physical Systems: Introduction, Differential equation representation of physical systems, Transfer function concepts, Block diagram reduction, Signal flow graphs, Mason's Gain formula

Time Response Analysis: Introduction, Standard test signals, Time response of first and second order systems, steady state error and error coefficients, P, PI and PID type controllers.
Stability of linear systems-Routh-Hurwitz criterion, Nyquist criterion, root locus, Bode-plot, stability margins, effects of system gain on stability.
Compensation: Design of Lag, lead and lag-lead compensator.
State Variable Analysis: Concept of state, state variables, state mode transfer function decomposition, State models of linear continuous-time systems. Basic concepts of state and output feedback controller. Controllability & Observability.
Texts/References

1. Nagrath I J & Gopal M : Control Systems Engineering, New Age International Pub.
2. K. Ogata: Modern Control Engineering, Prentice Hall publishers
3. S. Hasan Saeed: Automatic Control Systems, S.K. Kataria & Sons Publisher
4. F. Golnaraghi, B. C. Kuo: Automatic Control Systems, Wiley Pub.

Courses objective:

1. To understand the fundamental concept of open loop and closed loop control systems
2. To understand the mathematical modelling of any given physical system
3. To study the time response analysis of various 1st order and 2nd order control systems
4. To study and analyze various control system controllers, i.e., P, PD, PI and PID
4. To study the stability analysis of closed loop and open loop control systems
5. To study the design of various kinds of compensators

Course content :

Unit- 1
Introduction: Control systems, Physical elements of a control system, effects of feedback.
Unit 2
Mathematical Model of Physical Systems: Introduction, Differential equation representation of physical systems, Transfer function concepts, Block diagram algebra, Signal flow graphs, Mason's Gain formula
Unit – 3
Control System Components: Control system components: Potentiometer, ac & dc tachogenerator, ac & dc servomotor, amplidyne, synchro, resolver, error detector, remote position control.
Unit – 4
Time Response Analysis: Introduction, Standard test signals, Performance indices, Time response of first and second order systems, steady state error and their minimization, error coefficients, P, PI and P-I-D type controllers.
Unit – 5
Stability Analysis in Time Domain: The concept of stability, Assessment of stability from pole positions, Necessary conditions for stability, Routh Stability Criterion, Relative stability analysis.
Unit – 6
Root Locus Technique: Introduction, The root locus concept, Root locus construction rules, Root contours, Case studies.
Unit – 7

Frequency Response Analysis: Introduction, Performance indices, Frequency response of second order systems, Polar plots, Bode plots, All pass systems, Minimum-phase and Non-minimum-phase systems, Illustrative examples

Unit – 8

Stability Analysis in Frequency Domain: Introduction, A brief review of Principle of Argument, Nyquist stability criterion, Assessment of relative stability – Gain Margin and Phase Margin, Closed loop frequency response, Illustrative examples.

Unit – 9

Compensator design in frequency domain: Lead, lag and lag-lead compensation.

Course outcome :

After successful completion of the course the students will be able to:

1. Demonstrate an understanding of the fundamentals of open loop and closed loop control systems.
2. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
3. Determine the time-domain responses of first and second-order systems to various test inputs like step, ramp, parabolic, impulse signals.
4. Determine the stability of a closed-loop control system using various stability analysis techniques like Routh-Hurtwiz criterion, Nyquist Criterion, Bode plot, Root locus.
5. Understand and analyze various control system controllers, i.e., P, PD, PI and PID.
6. Design various compensators based on stability analysis.

Subject : Control System-I Lab L T P: 0-0-1 Credit : 1

Courses objective:

1. To understand the mathematical modelling of any given physical system
2. To study the time response analysis of various 1st order and 2nd order control systems using the standard reference signals
3. To study and analyze various control system controllers, i.e., P, PD, PI and PID
4. To study the stability analysis of a given control systems
5. To study the input/output characteristics of various control system components

Course content :

Unit 1:

To determine the transfer function by Block Diagram reduction and verification of output by a) MATLAB simulink modelling b) MATLAB programming.

Unit 2

Time response analysis of a) 1st order system for step, ramp, parabolic and impulse response b) 2nd order system for step, ramp, parabolic and impulse response

Unit – 3

Step response analysis of a) 1st order system with an additional pole/zero b) 2nd order system with an additional pole/zero

Unit – 4

To study the effect of various controller actions (P, PD, PI, PID) on the output response of a second order system.

Unit – 5

Verification of the stability of a given closed loop control system using RH Criterion and Pole Zero Mapping

Unit – 6

To determine the natural frequency of oscillation and damping ratio for a second order and third order system

Unit – 7

Verification of the stability of a given closed loop control system using Bode plot and Nyquist plot. Study of Root locus diagram.

Unit – 8

To study the input-output characteristics of Potentiometer. Use of POT set as error detector.

Unit – 9

To study the torque speed characteristics of dc servomotor.

Unit – 10

To study the input-output characteristics of dc tachogenerator.

Course outcome:

After successful completion of the course the students have:

1. a strong knowledge of MATLAB software for solving control system related problems including time response analysis, stability analysis, etc.
2. an understanding of the working principle and input output relation of some control system components like dc servomotor, tachogenerator and potentiometer.
3. an ability to do various engineering projects.

5. Electromagnetic Field Theory L T P : 3-0-0 Credit : 3

Electrostatic field: dielectric interface, Laplace and Poisson's equations, energy & force. Steady currents: continuity equations, Ohm's law, Joule heating, current flow in materials, Eddy current, skin effect, displacement current. Magnetostatic field: Ampere's circuital law, scalar & vector potentials, Laplace and Poissions equations. Electromagnetic induction: Maxwell's equations; power flow and Poynting vector. Solutions of field equations in rectangular, cylindrical and spherical coordinate system, radiation generation, propagation of electromagnetic waves, various boundary value problems, principle of electromagnetic radiation & interaction with matter; scientific and engineering applications of electro-magneticradiation.

Text Books:

1. W H Hayt & J A Buck, *Engineering Electromagnetic*, 7th Edition, Tata McGrawHill.
2. J D Krauss, *Electromagnetic with application*, 5th Edition, Tata McGrawHill.

Reference Books:

1. J. A. Edminister , *Schaum's outline of theory and problems of electromagnetics*, 2nd edition, McGraw- Hill Professional
2. A Pramanik, *Electromagnetism – Theory and Applications*, Prentice-Hall ofIndia

Course Objective:

1. To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields.
2. To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as electronic electromagnetic structures.
3. To develop a strong background in electromagnetic theory and use various mathematical tools to solve Maxwell equations in problems of wave propagation and radiation.

Course content :

Unit- 1

Electrostatic field : Dielectric Interface, Laplace and Poisson's equation, Energy and force, Electric flux density, Coulomb's Law, Boundery condition for electric field

Unit – 2

Magnetostatic field : Magnetic flux density, Ampere's Law, Scalar & Vector potential, Boundery condition for magnetic field, Laplace & Poission's eequation

Unit – 3

Steady Currents: Current flow in materials, Eddy current, Skin effect, Skin depth, Displacement current, Ohm's law, Joule heating

Unit – 4

Electromagnetic Induction: Maxwell's equations, Gauss Law, Faraday's Law, Biot savart law, Four Maxwell's equations from above Law, Power flow and Poynting vector

Unit – 5

Electromagnetic Waves: The wave equation for E, The wave equation for B, the time-independent wave equation for E, Transverse EMW propagation in free space, Transverse EMW propagation in conductive media

Unit-6

Guided fields: Waveguides, Dispersion, phase and group velocities, attenuation, inhomogeneous waveguides, Rectangular metallic waveguide

Unit – 7

Scientific & Engineering applications of electromagnetic radiation: FM wavelength radio waves, Transmission of energy through a vacuum, communication technology

Course outcome :

After study through lectures and assignments, students will be able to:

1. Apply vector calculus to static electric-magnetic fields in different engineering situations.
2. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
3. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
4. Relate the volume charge density and electric flux density in the bounded area
5. Compute the spatial variations of physical quantities by using various coordinate systems

6. Seminar

6^{th} Semester

1. Power System II   LTP: 3-1-1.5   Credit: 5.5

Symmetrical fault and unsymmetrical faults: symmetrical components single line diagram for a balanced system, analysis of three phase fault, construction of sequence networks under fault conditions (L-G, L-L, and L-L-G). Analyses of unsymmetrical faults using symmetrical components. Load flow analysis: static load flow equation, system variables, bus admittance matrix, bus classification, Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods, comparison of methods. Voltage and frequency control. Economic aspects of power system. Power System transient Stability: synchronous generator connected to an infinite bus, power angle curve, steady state, transient, swing equation, equal area and criteria of stability. Brief ideas about power system protection and circuit breakers: general requirements of circuit breakers. Different types of circuit breakers, their construction, operating principles and relative merits and demerits. Fundamental principles of protective relays, their properties and block diagrams. Introduction to HVDC Transmission, Basic configurations and its merit.

Text Books:

1. W.D. Stevenson, 'Elements of Power Systems Analysis', 4^{th} Edition, McGraw Hill,1982.
2. I.J. Nagrath and D.P. Kothari, 'Modern Power System Analysis', 2^{nd}Edition. TMH, New Delhi, 1989.

Reference Books:

1. Power System Economics: Designing Markets for Electricity – Steven Stoft IEEE Press ' A John Wiley & Sons , INC., Publication.
2. J Duncan Glover, Mulukutala S. Sarma and Thomas J. Overbye, *Power System Analysis and Design*, Cengage Learning India Pvt. Ltd. 4^{th}Edition.
3. Olle I. Elgerd, *Electric Energy Systems Theory-An Introduction*, Tata McGraw Hill.

Courses objective:

1. To understand different transmission line parameters, calculation of line inductances and capacitances, introduction to symmetrical and unsymmetrical components
2. To understand different symmetrical and unsymmetrical faults, and the use of symmetrical and unsymmetrical components in fault analysis and correction
3. To obtain voltage and power profiles for each bus in a power network using different Load flow analysis such as, Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods.
4. To analyse the power system from stability point of view, understand the generation of power angle curve, steady state and transient stability of power system, swing equations and other stability criteria
5. Introduction to brief ideas about power system protection and circuit breakers, Types of circuit breaker their general requirements of circuit breakers and construction. Different types of circuit breakers and relays, their construction and operating principles.

Course content :

Unit- 1 Introduction:
Introduction to symmetrical and unsymmetrical components of transmission lines and determination of various line parameters.
Unit- 2 Power System Fault Analysis:
Symmetrical fault and unsymmetrical faults: symmetrical components single line diagram for a balanced system, analysis of three phase fault, construction of sequence networks under fault conditions (L-G, L-L, and L-L-G). Analyses of unsymmetrical faults using symmetrical components.
Unit- 3 Load Flow Analysis:
Static load flow equation, system variables, bus admittance matrix, bus classification, Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods, comparison of methods.
Unit- 4   Power System Stability:
Power System transient Stability: synchronous generator connected to an infinite bus, power angle curve, steady state, transient, swing equation, equal area and criteria of stability.

Unit– 5 Power System Protection:
General requirements of circuit breakers. Different types of circuit breakers, their construction, operating principles and relative merits and demerits. Fundamental principles of protective relays, their properties and block diagrams.

Course outcome :
After successful completion of the course the students will be able to:
1. Understand the symmetrical and unsymmetrical components of power system
2. Can identify various faults both symmetrical and unsymmetrical and can analyse it cause and remedies.
3. Can calculate each bus voltage and power parameters in a connected network using various load flow method and can compare and deduce best results of load flow amongst the various method introduced.
4. Will be able to determine the stability criteria of a power network and can analyse its steady state and transient states.
5. Will have ideas about the protection scheme involved in power system and various components used to protect the system against faults. They will have the understanding of the operations, constructions and requirements of various relays and circuit breakers and their uses in different types of fault.

Subject: Power System Lab II L T P: 0-0-1.5 Credit: 1.5

Courses objective:

1) To understand long, medium transmission line parameters.
2) To calculate line voltage regulation & transmission efficiency.
3) To study Ferranti effect in long transmission line.
4) To perform experiments to measure current, voltage of series RL, RC, RLC circuits.
5) Understanding different types of relays.

Course content :

Unit- 1
To calculate the transmission parameters of two port network for long transmission line.
Unit- 2
To calculate the transmission parameters for medium transmission line.
Unit- 3
Testing of Ferranti effect of a long transmission line.
.Unit- 4
To calculate Voltage regulation of long transmission line.
Unit– 5
To calculate Transmission efficiency of long transmission line.
Unit– 6
Characteristic study of series RL,RC, RLC circuit.
Unit– 7
To study the working of earth fault relay in EHV transmission line simulator.
Unit– 8
To study the working of overcurrent relay in EHV transmission line simulator.
Unit– 9
To study the working of undervoltage relay in EHV transmission line simulator.
Unit– 10
To study of the operation of electromechanical directional over current relay.
Unit– 11
To study of the operation of microprocessor based over current relay.
Unit– 12
To study of the operation of static biased differential relay.
Unit– 13
To study of the operation of microprocessor based impedance relay.

Course outcome :
After successful completion of the course the students will be able to:

1. Understand the A,B,C,D parameters in long transmission line of power system
2. Can identify the different types of relays and can analysis it cause and remedies.
3. Introduction to brief ideas about power system protection and circuit breakers, Types of circuit breaker their general requirements of circuit breakers and construction. Different types of circuit breakers and relays, their construction and operating principles.
4. Will be able to determine the stability criteria of a power network and can analyse its steady state and transient states.
5. Will have ideas about the protection scheme involved in power system and various components used to protect the system against faults. They will have the understanding of the operations, constructions and requirements of various relays and circuit breakers and their uses in different types of fault.

2.Digital Signal Processing L T P: 3-0-1 Credit : 04

Design of fir digital filters: window method, frequency sampling method, Park-McClellan's method. Design of IIR digital filters: bilinear transformation, butterworth, chebyshev and elliptic approximations; frequency transformation lowpass, bandpass, bandstop and high pass filters.

Structures of DSP: direct, parallel, cascade and lattice, effect of finite register length in FIR filter design, limit cycle in IIR filters. Introduction to multi-rate signal processing. Hardware implementation considerations in DSP, selected applications of digital signal processing.

Texts Books:
1. S. K. Mitra, *Digital signal processing: A computational approach*, Tata McGrawHill
2. A.V. Oppenheim and R.W. Schafer, *Discrete Time Signal Processing*, PrenticeHall,

References Books:
1. L.R. Rabiner and B. Gold, *Theory and Application of Digital Signal Processing*, PrenticeHall,
2. J.R. Johnson, *Introduction to Digital Signal Processing*, Prentice Hall,1992.

Courses objective:

1. To introduce students about basic signals and systems in the field of digital signal processing.
2. To understand the different digital filters and processors and their operating principles.
3. To Know about different methods and mathematical tools to analyze digital signals and digital systems.
4. To know the industrial practices of Digital signal processors.
5. To introduce students about specific knowledge to use modern tools necessary for electrical projects.

Course content :

Unit- 1
Design of FIR digital filters: window method, frequency sampling method, Park-McClellan's method.
Unit 2
Design of IIR digital filters: bilinear transformation, butterworth, chebyshev and elliptic approximations; frequency transformation lowpass, bandpass, bandstop and high pass filters.
Unit – 3
Structures of DSP: direct, parallel, cascade and lattice, effect of finite register length in FIR filter design, limit cycle in IIR filters.
Unit – 4
Introduction to multi-rate signal processing. Hardware implementation considerations in DSP, selected applications of digital signal processing.

Course outcome:

After successful completion of the course the students will be able to:
1. Design a digital systems, component or process to meet desired needs in electrical engineering.
2. Structural analysis of digital filters and systems.
3. Look for improvement of available systems.
4. Design digital systems to improve the functioning process.

5. Use the methods and skills for electrical projects.
6. Use your technical knowledge to the industrial applications.

Subject : Digital Signal Processing Lab LTP: 0-0-1 Credit : 01

Courses objective:

1. To know the procedures for sampling, signal operations, various digital systems.
2. To perform experiments to convolution, correlation etc.
3. To design and implement various digital filters for development of digital instruments.
4. To know the industrial practices of Digital signal processors.
5. To introduce students a knowledge of using modern tools necessary for electrical projects.

Course content :

Unit- 1
Design elementary signals and their basic operations.
Unit 2
Perform linear and circular convolution and auto and cross correlations.
Unit – 3
Design Up-sampling and Down-sampling operations.
Unit – 4
Perform z-transform and Fourier series and Fourier transforms.
Unit – 5
Design IIR and FIR filter. Lattice structures.
Unit – 6
Perform impulse invariance method and Bi-linear transformations.

Course outcome:

After successful completion of the course the students will be able to:
1. Design various elementary signals and their operations.
2. Design to perform linear and circular convolution and auto and cross correlations.
3. Use Matlab software as a base of designing.
4. Calibrate and test Sampling theorem.
5. Perform z-transform and Fourier series and Fourier transforms. Design IIR and FIR filter. Lattice structures. Perform impulse invariance method and Bi-linear transformations.
6. Take up projects to apply the learned techniques and skills.

3. Industrial Instrumentation L T P: 3-1-1 Credit : 05

Measurement of non-electrical quantities: Transducers: Definition and introduction, classification: Active/ passive, primary/secondary, etc. specific transducers: strain gauge, LVDTs and Signal conditioning circuit, Measurement of temperature, pressure, flow and level, Static and dynamic characteristics of sensors. Resistive, Inductive and Capacitive sensors, Piezo-electric and Ultrasonic sensors and its application in process and biomedical instrumentation, Measurement of viscosity, humidity, thermal conductivity, Nucleonic gauges: Sources and Detectors and its application. Interfacing Sensors and actuators: LabVIEW technique. Optical sensors including infrared, laser and optical fiber.

Text Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill,
2. A.E. Fribrance, Industrial Instrumentation Fundamentals, McGraw Hill.
3. J. P. Bentley, Principle of measurement system, Pearson Education India, 1988.
4. R. P. Areny, J. G. Webster, Sensor and Signal Conditioning, John Wiley & Sons, Inc. 2001.

Reference Books:

1. Donald P. Eckman, Industrial Instrumentation
2. E.O. Doebeline & D.N Manik, Measurement systems Application and design, 5th edition, McGraw-Hill.

Courses objective:

1. Develop knowledge about the different transducer technologies
2. Characterizations and modeling of different transducer systems.
3. Designing instrumentation systems.
4. Relate the different non-electrical measurement technologies with other engineering subjects to extend the boundary of research areas.

Course content:

Unit- 1
Measurement of non-electrical quantities: Transducers: Definition and introduction, classification: Active/ passive, primary/secondary, etc. specific transducers: strain gauge, LVDT, thermistor and thermocouple.
Unit 2
Static and dynamic characteristics of sensors. Resistive, Inductive and Capacitive sensors
Unit – 3
pH and conductivity sensors, Piezo-electric and ultrasonic sensors and its application in process and biomedical Instrumentation. Measurement of viscosity, humidity and thermal conductivity.
Unit – 4
Nucleonic gauges: Sources and Detectors and its application. Instrumentation system Design. Optical sensors including infrared, laser and optical fiber.

Course outcome:

1. Student's ability to understand the measurement of non-electrical quantities and transduction principle.
2. Student's ability to understand the fundamentals of various sensors and transducer systems.
3. Student's ability to analyse and characterize transducer systems.
4. Student's ability to identify the problems in the subject domain.
5. Student's ability to understand the ambient parameters for sustainability.

Subject: Industrial Instrumentation Lab L T P: 0-0-1 Credit: 01

Courses objective:

1. Learn working principle, interfacing and various applications of different types of thermocouple, with special emphasis on Pt type and K type thermocouple.
2. Learn working principle, interfacing and various applications of different types of humidity and gas sensors.
3. Learn working principle, interfacing and various applications of different types of photo-diode and photo-transistors.
4. Learn working principle, interfacing and various applications of different types of IR Transmitter and receivers.
5. Learn working principle, interfacing and various applications of different types of Ultrasonic sensors.
6. Learn working principle, interfacing and various applications of different types of Hall-effect sensors.
7. Learn working principle, interfacing and various applications of different types of Distance measuring sensors.
8. Learn working principle, interfacing and various applications of different types of NTC and PTC sensors.
9. Learn working principle, interfacing and various applications of different types of Piezo Pressure sensors and Sound Sensors.
10. Learn working principle, interfacing and various applications of different types of LEDs with special emphasis on Red, White and IR LEDs.

11. Learn working principle, interfacing and various applications of different types of Proximity Sensors.
12. Learn working principle, interfacing and various applications of Mercury Switch, Limiting Switch and Reed Relay.

Course content:

Experiment - 1

Working principle, interfacing and various applications of different types of thermocouple, with special emphasis on Pt type and K type thermocouple.

Experiment 2

Working principle, interfacing and various applications of different types of humidity and gas sensors.

Experiment – 3

Working principle, interfacing and various applications of different types of photo-diode and photo-transistors.

Experiment – 4

Working principle, interfacing and various applications of different types of IR Transmitter and receivers.

Experiment – 5

Working principle, interfacing and various applications of different types of Ultrasonic sensors.

Experiment – 6

Working principle, interfacing and various applications of different types of Hall-effect sensors.

Experiment – 7

Working principle, interfacing and various applications of different types of Distance measuring sensors

Experiment – 8

Working principle, interfacing and various applications of different types of NTC and PTC sensors.

Experiment – 9

Working principle, interfacing and various applications of different types of Piezo Pressure sensors and Sound Sensors.

Experiment – 10

Working principle, interfacing and various applications of different types of LEDs with special emphasis on Red, White and IR LEDs.

Experiment – 11

Working principle, interfacing and various applications of different types of Proximity Sensors.

Experiment – 12

Working principle, interfacing and various applications of Mercury Switch, Limiting Switch and Reed Relay.

Course outcome:

On successful completion of the course, the students will be able to
1. Understand the basics of different types of thermocouple, with special emphasis on Pt type and K type thermocouple and their applications in Industries.
2. Understand the basics of different types of humidity and gas sensors and their applications in Industries.

3. Understand the basics of different types of photo-diode and photo-transistors and their applications in Industries.
4. Understand the basics of different types of IR Transmitter and receivers and their applications in Industries.
5. Understand the basics of different types of Ultrasonic sensors and their applications in Industries.
6. Understand the basics of different types of Hall-effect sensors and their applications in Industries.
7. Understand the basics of different types of Distance measuring sensors and their applications in Industries.
8. Understand the basics of different types of NTC and PTC sensors and their applications in Industries.
9. Understand the basics of different types of Piezo Pressure sensors and Sound Sensors and their applications in Industries.
10. Understand the basics of different types of LEDs with special emphasis on Red, White and IR LEDs and their applications in Industries.
11. Understand the basics of different types of Proximity Sensors and their applications in Industries.
12. Understand the basics of different types of Mercury Switch, Limiting Switch and Reed Relay and their applications in Industries.

4. Principles of Communication L T P: 3-0-1 Credit : 04

Analog communication : introduction to communication systems, communication channels and propagation characteristics, basics of amplitude modulation and angle modulation - spectra, circuits and systems, frequency division multiplexing, performance of analog communication systems in AWGN.
Digital communication: A-D conversion, quantization and companding, PCM, DPCM, ADPCM, DM, ADM, time division multiplexing, baseband transmission, data regenerators and clock recovery, inter-symbol interference, equalizers, digital modulation and demodulation: FSK & MSK, PSK & QPSK, QAM with their spectra, circuits and systems, Information theory: entropy, mutual information & channel capacity, basics of spread spectrum.

Text Books:

1. S.S. Haykin, *An Introduction to Analog and Digital Communication Systems*, Wiley Eastern1989
2. R.B. Carlson, *Communication Systems*, 3rd international edition, McGraw Hill,1986.

Reference Books:

1. B.P. Lathi, *Communication Systems*, John Wiley,1987.
2. H. Taub and D.L. Shilling, *Principles of Communication Systems*, McGraw Hill international student edition,1971.

Courses objective:

1.To acquire knowledge about principle and techniques of modern communication system.

2.To acquire knowledge of analog communication systems in additive white Gaussian noise.

3.To acquire knowledge in various methods of analog and digital communication, including amplitude modulation, frequency modulation and phase modulation.

4.To acquire knowledge about the theory of probability, random process and optimum detection.

5.To design a communication system and validate the idea by using computer simulation.

6.To acquire knowledge of different digital modulation and demodulation of amplitude shift keying, frequency shift keying, phase shift keying with their spectra and circuits.

Course Content:

Unit- 1
Analog communication: introduction to communication systems, signals and spectra, electromagnetic spectrum and its usage, communication channels and propagation characteristics.

Unit 2
Amplitude modulation and demodulation - spectra, circuits and systems, frequency modulation/demodulation, frequency division multiplexing, pulse modulation and demodulation.
Unit – 3

Performance of analog communication systems in AWGN
Unit – 4
Digital communication: A-D conversion, quantization and companding, PCM, DPCM, ADPCM, DM, ADM, time division multiplexing, baseband transmission, data regenerators and clock recovery, inter-symbol interference, equalizers.
Unit – 5
Digital modulation and demodulation, ASK, FSK, PSK and their spectra, circuits and systems, carrier recovery.

Course outcome:

After successful completion of the course, the students will be able to:

1. Demonstrate an understanding of the fundamentals of communication systems
2. Demonstrate an understanding of the basic signal and systems, Fourier transform and its properties.
3. Design band pass, low pass and high pass filters.
4. Understand the basic knowledge necessary for transmitting and receiving information.
5. Understand different types of analog and digital modulation and demodulation.
6. Learn the theory of probability, random variables and stochastic processes. They will also able to understand noise in the communication systems and how the optimum detection works.

Subject : Principle of Communication Lab L T P: 0-0-1 Credit : 1

Courses objective:

1. To acquire knowledge about principle and techniques of modern communication system.
2. To acquire knowledge of different analog filters like LPF, HPF, etc.
3. To acquire knowledge in modulation and demodulation of AM.
4. To acquire knowledge in modulation and demodulation of FM.
5. To design a communication system and validate the idea by using computer simulation.
6. To acquire knowledge of different digital modulation and demodulation of amplitude shift keying, frequency shift keying, phase shift keying with their spectra and circuits.

Course Content:

Unit- 1
Design of High pass and Low pass filters **.**
Unit 2
Pre-emphasis & De-emphasis
Unit – 3
Generation of AM signals
Unit – 4
Demodulation of AM signals.
Unit – 5
Generation of FM signals.
Unit - 6
Demodulation of FM signals
Unit – 7

Generation of PAM signals.
Unit - 8
Demodulation of PAM signals
Unit – 9
Generation of ASK signals.
Unit - 10
Generation of PSK signals
Unit –11
Generation of BPSK signals

Course outcome:

After successful completion of the course, the students will be able to:

1. Demonstrate an understanding of the fundamentals of communication systems.

2. Demonstrate an understanding of the basic signal and systems, Fourier transform and its properties.

3. Design low pass and high pass filters.

4. Understand the basic knowledge necessary for transmitting and receiving information.

5. Understand different types of analog modulation and demodulation.

6. Understand different types of digital modulation and demodulation.

5. Seminar (Project Related)

7th Semester

1. Electrical Drives   L T P: 3-0-1.5   Credit: 4.5

Basic Electric drives and its components, Torque speed characteristics of different types of loads, Selection of motor power ratings, Torque speed characteristics and speed control of Separately excited and series DC motor drives: Armature resistance control, combined armature voltage and field control, four quadrant operation.

Induction motor drive: toque speed characteristics and speed control of stator voltage controlled and v/f controlled IM drive, various performance like T/I ratio, Issues of efficiency, four quadrant operation, speed control of slip ring IM: static Scherbius drive. Toque speed characteristics of v/f controlled IM drive. Torque speed characteristics and speed control of synchronous motor drive, principle of operation of BLDC motor and switched reluctance motor drives.

Text Books:

1.G. K. Dubey, *Fundamentals of Electrical Drives*, CRC Press, 2002

2.R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt Ltd., New Delhi,2003.

Reference Books:

1.Bimal K.Bose, *Modern Power Electronics and AC Drives*, Pearson Education Pvt. Ltd., 2003.

2.Paul C. Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, Analysis of Electric Machinery and Drive systems, Wiley publication, 3rd edition, 2013.

Course objective:

1. Students are exposed to knowledge of dc and ac drives.
2. Students would be able to analyse the performance of dc and ac drives.
3. Design and analysis of different drive system.
4. To find the industrial application of drive.

Course content:

Unit- 1

Basic power electronic drive system components. Different types of loads, shaft-load coupling systems, selection of motor power ratings, review of starting, braking and speed control of DC and IM.

Unit 2

Transient analysis during starting braking & speed control of dc & ac drives, calculation of energy loss, stability, single phase and three phase converter fed dc motor drive. Four quadrant operation, constant flux operation and field weakening, chopper fed drives, braking and speed reversal of dc motor drives using choppers.

Unit – 3

Three phase induction motor drives - ac voltage controlled drives –- VSI fed induction motor drive – stator side control – scalar control and vector control – rotor side control - slip power recovery scheme - CSI controlled induction motor drives.

Unit – 4

Regeneration in drives: dynamic braking, regenerative braking, dc injection, plugging. Basic concepts of synchronous motor drives, switched reluctance motor drives and permanent magnet motor drives.

Course outcome:

1.Basic concept of drive system, load, selection of motor, starting and braking.
2. Inculcation of knowledge of different control strategies for dc Motor drive.
3. Exposure to control strategies of IM drives.
4. Exposure to different control strategies for Synchronous Motor, SRM and PM motor drives.

Subject : Electrical Drives Lab L T P: 0-0- 1.5 Credit :1.5

Course objective:

1. To understand the operation of Induction motor and control its speed.

2. To understand the operation of DC motor and control its speed.
3. To understand the operation of BLDC (Brush Less) motor and control its speed
4. To understand the operation of PMSM (Permanent Magnet Synchronous Motor) and control its speed.
5. To understand the operation of SRM (Switched Reluctance Motor) and control its speed.

Course content:

Unit-1

(i) Control the speed of the induction motor by varying the voltage with fixed frequency.

(ii) Control the speed of the induction motor by varying frequency with fixed voltage.

(iii) Control the speed of the induction motor by varying both voltage and frequency.

Unit-2

(i) Study the open loop speed control of DC motor by armature control using PEC16HV2B & PEC14HV4D module.

(ii) Study the open loop speed control of DC motor by field control using PEC 16HV2B & PEC14HV4D module.

Unit-3

Open loop speed control of DC motor using power electronics trainer kit.

Unit-4

Closed loop speed control of DC motor with speed feedback.

Unit-5

Study the characteristics of DC drive using Jones Chopper.

Unit-6

Control the speed of 3 phase slip ring Induction motor using the PEC16HV10B trainer module.

Unit-7

Study the open loop and closed loop speed control of AC Motor by using MICRO 2812 and PEC16DSMO1 (IPM) module.

Unit-8

Study the open loop and closed loop speed control of BLDC Motor by using MICRO 2812 andPEC16DSMO1 (IPM) module.

Unit-9

Control the speed of PMSM motor using Intelligent Power Module (PEC16DSMO1) and Micro-2812 trainer.

Unit-10

Control the speed of Switched Reluctance Motor using Micro-2812 trainer and SRM power module (PEC16DSMO15).

Unit-11

Study of speed control of dc motor with an inner current loop and outer speed loop.

Course outcome:

After successful completion of the course students will be able to

1. Control the speed of three phase Induction motor, DC motor, BLDC motor, PMSM and SRM using Micro 2812.

2. Use oscilloscope, micro 2812 and different converter module.

3. Identify and investigate hardware problem associated with the trainer kits.

4. Perform work in a team.

5. Receive technical instruction, communicate their need and write a lab report.

6. Learn professional ethics and responsibilities and norms of the engineering practice.

2. Engineering Economics L T P: 3-0-0 Credit: 03

Introduction – engineering economy and its important, want activity satisfaction of wants. Resources planning and distribution in economic system – Laissez Faire and socialism. Factors of production and concept of optimum. Laws of return. Demand - elasticity of demand, demand – estimation, market research, supply and industrial costs. Money – value of money, quantity theory; inflation and deflection. Neural network and its applications. Banking - role in commercial banks credit and its importance in industrial financing, sources of finance Reserve bank of India and its functions. Business management and organization, proprietorship, partnership and joint stock company – their formation, finance and management. Elements of taxation, insurance, business combinations. Basic principles of management. Industrial record keeping : double entry system – journal, ledger, trial balance, cash book, preparation of final accounts, trading and profit and loss account and balance sheet. Industrial costs and their classifications – material cost control, labour cost control and overhead cost control. Depreciation and replacement studies; financial control ratio analysis and their interpretation for industrial control. Budgetarycontrol.

Text Books:

1. H L Ahuja, *Business Economics* , S Chand's & CompanyLtd.
2. Sampat Mukherjee, *Managerial Economics*, New Age International (P)Ltd.

Reference Books:

1. O P Chhabra, *Managerial Economics*, Tata McGrawHill

Course content:

Unit- 1

Engineering Economics- meaning, nature, scope and subject matter

Unit 2

Utility- definition, total, marginal and average; cardinal utility theory; indifference curves theory; **Demand**- factors effecting demand, elasticity of demand- different types of elasticity, classification of goods based on various elasticity of demand

Unit – 3

Production- Production function; Iso-quant; returns to scale; Total, Average & Marginal Product; law of variable proportions; Cobb-Douglas production function; Iso-cost curve; Derivation of cost curve from production function; Production optimization; expansion path

Unit – 4

Cost- short run and long run cost (the 'Envelope Curve'); shape of different types of cost curves; **Revenue-** total revenue and marginal revenue, relation between marginal revenue and price elasticity of demand

Unit – 5

Firm- different types of firm and its characteristics; traditional theory of firm; objectives of firm

Unit – 6

Introduction to Accounting- Definition of Accounting and accountancy, objectives of accounting, users of accounting information, Double Entry system of Book-Keeping, Journal and Ledger, Cash book, Trial balance.

Unit – 7

Final Accounts- Basic concepts, uses and preparation of Trading account; Profit and Loss account; and Balance Sheet. Issue and Forfeiture of Share and Re-Issue of Company.

Unit – 8

Introduction to Costing- Elements of Cost, Direct Materials, Direct Labour, Direct Expenses, Overheads, Production, Office and Administration, Selling and Distribution, Allocation of overhead, machine hour rate, labour hour rate, practical problems.

Course outcome:

1. Be able to identify and explain economic concepts and theories related to the behavior of economic agents present in market.
2. Be able to analyse the impact of various government policies in production and profitability of the company.
3. Be able to identify the basic features of alternative representations of human behavior in economics.
4. Be able to understand the impact various decisions or transactions will have on the company's statements and financial health.
5. Be able to comfortably communicate with senior financial and non-financial leaders about financial statement issues and the financial impact of business decisions.

2. Elective-II
3. Elective-III
4. Project-I

8th Semester

1. Industrial Management L T P: 2-0-0 Credit: 02

Introduction to management, evolution of scientific management, modern management. Principles. Elements of management; Planning, organizing, staffing, directing, coordinating, reporting, budgeting. Core concepts of marketing. Need, want, demand, product, value, satisfaction, marketing mix- product, price, place, promotion. Financial management, objectives, scope, techniques of investment analysis, pay- back period, accounting rate of return, working capital, cost of capital. Sources of financing. Technology management. Product design. Types of production system. Plant location-factors to be considered. Plant layout. Types of layout. Inventory management. Significance of HRM. HR planning job evaluation. Recruitment and selection. Placement and induction. Training. Performance appraisal. Compensation. Industrial relations. Microeconomics. Demand and supply. Forecasting techniques. Cost and revenues. Competitive nature of firms. Keynesian economics. Aggregate demand and supply. Employment determination. National income. Trade cycle. Inflation. Index numbers. Capital budgeting. Cash flow analysis. Balance sheet. Risk analysis and decision making. Impact of liberalization, privatization and globalization. Locating the firm in a global economy. Fiscal policy. Taxation-principles. Exchange rate determination. Monetary policy. Functions of banks. Credit creation by commercial banks.

Text Books:

1. P.Kotler, Marketing Management, 12th edition,Pearson
2. P.Chandra, Financial Management Theory and Practice, 3rd edition, Tata McGraw Hill,

Reference Books:

1. K.Ashwathappa, Human Resources and Personnel Management, 3rd edition, Tata McGraw Hill
2. E.S.Buffa & R.K.Sarin, Modern Production/Operation Management , 8th edition,Wiley.

Courses objective:

1. To make the Engineering student know about the basic concepts, functions, principles and techniques of management and their application, which complement the technical skills to execute their capabilities successfully.

2. To make the Engineering student know about the basic concepts of finance in carrying out any project

Course content:

Unit- 1

Basic Concepts and functions of management: planning, nature, purpose and objective of planning; organizing: nature and purpose, authority and responsibility, staff bug; supply of human resources, performance appraisal. Controlling: system and process of controlling, control techniques.

Unit 2

Human resource Management and Marketing Management: nature and scope of human resource of planning, planning and development, recruitment and selection, career growth, grievances, motivation and its type, needs for motivation, reward and punishment, models of motivation. Leaders: kinds of leaders, leadership styles, roles and functions of leader; conflict management: kinds and causes of conflict, settlement of conflict, Group and team working, organizational design and development.

Unit – 3

Financial Management: Need of finance, kinds and sources of capital shares and debentures, fixed and working capital , capital structure of a firm, operating and financial leverage, EBIT and EPS analysis, financial ratio analysis : uses and natures, liquidity coverage ratios, practical problems.

Unit – 4

Investment decisions and forecasting of working capital: Kinds of capital Budgeting decisions, evaluation of proposals, capital discounting and non discounting based methods. Practical problems. Definition and importance of working capital. Working capital operating cycle, factors affecting Working capital, inventory management

Unit – 5

Cost Analysis and Cost Control: elements of cost, types of cost, direct and indirect, variable and fixed, labour cost, material cost, overhead cost, cost control techniques. Budget: meaning, kinds, budgetary controls, break even analysis, practical problems.

Unit – 6

Perfect Competition- Perfect Competition, Features; Short run and long run equilibrium of firm and industry, shut down point

Unit – 7

Monopoly- features, monopoly power, pricing under monopoly, price discrimination.

Unit – 8

Oligopoly- Features, kincked demand Curve, Cournot's Duoploy Model Cartels, Price leadership.

Unit – 9

Monopolistic Competition- Features, Pricing under monopolistic competition, Product differentiation.

Unit – 10

Macroeconomics- Inflation; Function of Central & Commercial Banks

Course outcome:

1. Be able to understand the principles of management and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
2. Be able to make a plan how to organize, control and motivate people.
3. Be able to understand the Cost analysis in the context of short and long term decision making and the use of discounted cash flow analysis.
4. Be able to identify and explain economic concepts and theories related to the markets, industry and firm structures.
5. Be able to pursue the larger objectives of the firm besides profit maximization.

2. Elective-IV
3. Elective-V
4. Grand Viva
5. Project-II

Electives II, III, IV&V

Sl. No.	Title	Lecture	Tutorial	Practical	Credit
1	Special Topics in Electrical Engineering I				
2	Special Topics in Electrical Engineering II				
3	Analysis and Control of Electrical Machines	3	0	0	3
4	Power Plant Engineering	3	0	0	3
5	Advanced Power Systems	3	0	0	3
6	Process Control & Automation	3	0	0	3
7	Opto-electronics Instrumentation	3	0	0	3
8	High Voltage Engineering	3	0	0	3
9	Electrical Machine Design	3	0	0	3
10	Advanced Power Electronics	3	0	0	3
11	Optical Engineering and Laser Instrumentation	3	0	0	3
12	Renewable Energy Technology	3	0	0	3
13	Solar Photovoltaic Systems	3	0	0	3
14	Network Synthesis	3	0	0	3
15	Embedded Systems	3	0	0	3
16	Pulse Width Modulation Technique	3	0	0	3
17	Power System Protection	3	0	0	3
18	Smart Grid Fundamentals with Renewable Integration	3	0	0	3
19	Artificial Intelligence and Expert System	3	0	0	3
18	Advanced Control Systems	3	0	0	3

1. Special Topics in Electrical Engineering I

Details syllabus and reference will be given in class at the beginning of semester

2. Special Topics in Electrical Engineering II

Details syllabus and reference will be given in class at the beginning of semester

3. Analysis and Control of Electrical Machines

Introduction to generalized theory: elementary energy converter of Gibbs and Adkins, transformer with movable secondary, transformer voltage and speed voltage, transformation from 3-phase to 2- phase, stationery axes to rotating axes, transformed impedance matrix, generalized torque equation. Derivation of DC machine from generalized machine, performance evaluation of DC machine and speed control. Three phase induction motor: transformation methods (stationary, rotor and synchronous frames) and corresponding equivalent circuits. Vector control and direct torque control. Three Phase synchronous motor: representation, Park transformation and control. Permanent magnet synchronous motors- machine model (d-q) and control methods, Switched reluctance motor drive and various power circuit configurations and control.

Text Books:

1. P.C. Krause, Analysis of Electric Machinery, McGraw Hill, New York, 1987.
2. R.Krishnan, Electric Motor Drives – Modeling, Analysis and Control, Prentice-Hall of India Pvt Ltd., New Delhi,2003.

Reference Books:

1. C.V. Jones, The Unified Theory of Electrical Machines, Butterworth, London, 1967.
2. P.Vas, Vector Control of A.C. Machines, Clarendon Press, Oxford 1990.

4. Power Plant Engineering

The introduction of the various sources of the energy, principal types of the power plants and combustion of fuels, the various cycles used in power plants, viz., Rankine cycle, regenerative cycle, binary vapour cycle, otto cycle, diesel cycle, duel combustion cycle, gas turbine cycles. Description of different aspects of steam power plant, layout of a modern steam power plant, fuel handling, combustion equipment for steam boilers, ash handling, dust collection, chimney draught, boiler accessories, steam nozzles, steam turbines, cooling towers, cooling ponds etc. IC engines used in such a plant and essential components of diesel power plants, combustion phenomenon in IC engines, its related topics, layout of a diesel engine power plants, general aspects of gas turbine used in such a plant along with the description of gas power cycle used in such turbines, operation of gas turbines, gas turbines power plants layout. Elements of hydro-electric power plant, hydro- electric turbines, plant, layout, hydro-electric plant controls, hydrology. General aspects of nuclear engineering, nuclear power systems, nuclear reactors and their description, nuclear energy, advantages of combined operation of plants, load division between power stations, hydro-electric plant in combination with steam or nuclear power plants, co-ordination of hydro-electric and gas turbine stations, co-ordination of different types of powerplants.

Text Books:

1. M.M.El-Wakil , *Powerplant Technology* , McGrawHill
2. Arora & Domkundwar , *A Course in Power Plant Engineering* , DhanpatRai

Reference Books

1. B.G.A. Skrotzki &W.A.Vopat, *Power Station Engineering & Economy* , Tata McGrawHill
2. M.V.Deshpande, *Elements of Electrical Power Station Design*,Wheeler

Courses objective:

1. Learn various sources of the energy, principal types of the power plants and combustion of fuels, the various cycles used in power plants, viz., Rankine cycle, regenerative cycle, binary vapour cycle, otto cycle, diesel cycle, duel combustion cycle, gas turbine cycles etc.
2. Learn Description of different aspects of steam power plant, layout of a modern steam power plant.
3. Learn the layout of a diesel engine power plants, general aspects of gas turbine
4. Understand basics of hydro-electric power plant, hydroelectric turbines, plant, layout, hydro-electric plant controls, hydrology.
5. Learn General aspects of nuclear engineering, nuclear power systems, nuclear reactors etc.
6. Understand advantages of combined operation of plants, load division between power stations, hydro-electric plant in combination with various sources.

Course content:

Unit- 1

Introduction: The introduction of the various sources of the energy, principal types of the power plants and combustion of fuels, the various cycles used in power plants, viz., Rankine cycle, regenerative cycle, binary vapour cycle, otto cycle, diesel cycle, duel combustion cycle, gas turbine cycles.

Unit 2

Thermal Power Plant: Description of different aspects of steam power plant, layout of a modern steam power plant, fuel handling, combustion equipment for steam boilers, ash handling, dust collection, chimney draught, boiler accessories, steam nozzles, steam turbines, cooling towers, cooling ponds etc.

Unit – 3

Diesel and Natural Gas Power Plant: IC engines used in such a plant and essential components of diesel power plants, combustion phenomenon in IC engines, its related topics, layout of a diesel engine power plants, general aspects of gas turbine used in such a plant along with the description of gas power cycle used in such turbines, operation of gas turbines, gas turbines power plants layout.

Unit – 4

Hydro-electric Power Plant: Elements of hydro-electric power plant, hydroelectric turbines, plant, layout, hydro-electric plant controls, hydrology.

Unit – 5

Nuclear Power Plant: General aspects of nuclear engineering, nuclear power systems, nuclear reactors and their description, nuclear energy, Operation, control, safety and regulation of nuclear power plants.

Unit – 6

Hybrid Power Plants: advantages of combined operation of plants, load division between power stations, hydro-electric plant in combination with steam or nuclear power plants, co-ordination of hydro-electric and gas turbine stations, co-ordination of different types of power plants.

Course outcome:

On successful completion of the course, the students will be able to
1. Understand the basics of a power plant, classify various types of power plants, understand various forms of energy deployed in power plants.
2. Understand the working, setup, operation and control of various thermal power plants, analyze their safety hazards and know how to avoid them.
3. Understand the working, setup, operation and control of Natural Gas and Diesel power plants, analyze their safety hazards and know how to avoid them.
4. Understand the working, setup, operation and control of various Hydro-electric power plants, various types of turbines, analyze their safety hazards and know how to avoid them.
5. Understand the working, setup, operation and control of various Nuclear power plants, various generations of reactors, analyze their safety hazards and know how to avoid them.

6. Understand the working, setup, operation and control of various hybrid power plants, calculate their suitability, analyze their safety hazards and know how to avoid them.

5. Advanced Power systems

Load frequency control: multi area load frequency control problem and concept of tie line control, speed governing system, AVR, AGC, economic operation of power system, introduction- incremental fuel rate curves, incremental fuel cost curve, constraints in economic operation of power system, cost function control for economic operation of a two area power system. Voltage control: methods of voltage control, tap changing transformer, HVDC operation and control: CIA, CC and CEA control. Determination of stable operating point. Introduction to FACTS – brief description of various FACTS devices and their principle of operation, role of FACTS in active and reactive power control. Harmonics in Power Systems – different sources of harmonics, effects of harmonics on power system performance and power quality. Introduction to SCADA and security monitoring.

Text Books:

1. A. J. Wood and B.F. Wollenberg, Power Generation, Operation and Control, 2nd edition, John Wiley.
2. K.R.Padiyar , HVDC Power Transmission Systems – Technology & System Interaction, Willey Eastern

Reference Books

1. E.W.Kimbark, Direct Current Transmission, Vol 1,Wiley Interscience
2. N.G.Hingorani & L.Guygyi, Understanding Facts, IEEE Press

6. Process Control & Automation

Concept of processes and units: process statics, mass and enthalpy balance. Modelling of process dynamics, Process control terminology, Modelling of chemical processes. Single loop control of standard first order process plants. Controller implementation: Electronic, Analog, Digital, Pneumatic, **Hydraulic** controllers. P, P-I, P-D, P-I-D control, Controller tuning, Ziegler-Nichlol's method. Simulation of process control systems. Boiler drum level control. Discrete controllers: Selection of sampling intervals, stability analysis, **controller design via frequency response analysis,pulse testing technique**. Cascade control, Feed-forward control, Ratio control, Multi-loop control, Interaction and decoupling non-linear effects in plants and controllers. Concepts of Modulating and Sequential control, Structure of Modulating control loops. Self-tuning and Multifunction controllers. Control valves, **Servo valves**. Process Actuators: Electrical, Pneumatic, Hydraulic, valve positioners, **P-I and I-P converters**. **Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA)**, **Distributed control system: Architecture and loop elements, interfacing units, operating stations.**

Text Book:

1. D. Patranabis, Principles of process control, Tata McGraw Hill.
2. **D.R. Coughanowr and L.B. Koppel, "Process Systems Analysis and Control", Mc-Graw Hill.**
3. Surekha Bhanot, Process Control - Principles And Applications, Oxford University Press.
4. **D.E. Seborg, T.F. Edgar and D.A. Mellichamp, Process dynamics and control, Wiley.**
5. George Stephanopoulos, Chemical process control: an introduction to theory and practice, Prentice-Hall.

Reference Book:

1. William L Luyben and Michael L. Luyben, Essential of Process Control, McGraw Hill.
2. P.Harriot, Process Control, McGraw Hill, New York.
3. B.G.Liptak, Instrumentation Engineers Handbook, CRC Press.
4. Mukhopadhay, Sen & Deb, "Industrial Instrumentation, Control and Automation", Jaico Publishing.
5. S.K. Singh, Process Control: Concepts, Dynamics and Applications, PHI Learning.
6. Douglas M Considine, Process instruments and controls handbook, McGraw-Hill.

Courses objective:

1. Introduction to basic components of process control loop and industrial instrumentation system.
2. Concept of different processes and modelling of process dynamics.
3. To study the characteristics of different control actions and implementation of different controllers along-with controller tuning techniques.
4. Analyzing the behaviour of different control actions.
5. Knowledge about basic components of final control element, characteristics of control valves, different types of control valves and process actuators.

Course content :
Unit- 1 Introduction:
Concept of processes and units: process statics, mass and enthalpy balance
Unit 2 Modelling of process dynamics:
Modelling of process dynamics, process control terminology, process instrumentation diagrams, modelling of chemical processes, single loop control of standard first order process plants.
Unit – 3 Controller and control actions:
Controller implementation: Electronic, analog, digital, pneumatic controllers. P, P-I, P-D, P-I-D control, controller tuning, Ziegler-Nichlol's method, frequency domain design.
Unit – 4 Complex control actions:
Cascade control, Feed-forward control, Ratio control.
Unit – 5 Simulation of process control systems:
Simulation of process control systems, boiler drum level control, discrete controllers: Selection of sampling intervals, stability analysis.
Unit – 6 Modulating and Sequential control:
Concepts of modulating and sequential control, structure of modulating control loops, self-tuning and multifunction controllers.
Unit -7 Multiloop interactions:
Multi-loop control, interaction and decoupling non-linear effects in plants and controllers.
Unit – 8 Control valves and process actuators:
Control valves. Process Actuators: electrical, pneumatic, hydraulic, valve positioners.
Unit – 9 Industrial instrumentation systems:
Industrial instrumentation systems: components, structure, specification,
Unit – 10 Selective, Adaptive control and Supervisory control:
Selective control systems, Self tuning and adaptive controllers. Supervisory control: objectives and implementation.

7. Opto-electronics Instrumentation

Introduction to electromagnetic field theory: Ray and wave optics, Reflection and transmission coefficients, Zero reflection condition. Modulators-Intensity, Polarization: Types of polarization, Polarization crystals. Birefringence, Isotropic and anisotropic media, Direct and indirect bandgap semiconductors. Phase, Read out schemes for modulation-polarimeter, Interferometer: Febry-perot interferometer, Finesses, Transportation media. Wave plates: Half wave plate, quarter wave plate, higher order wave plate. Optical fiber as a cylindrical wave guide, waveguide equations, Boundary conditions for cylindrical waveguide, Waveguide theory-slab waveguide, scalar wave equation. Opto-electronic devices: Sources-LED, Broadband calibration sources, Detectors-Photodiodes, PIN photodiodes, Photomultiplier tube, APD, Laser, Classifications of laser with its useful applications, Three level and Four level lasers, Laser diode, Optical fibre Characteristics: absorption and dispersion, Cylindrical waveguide, PANDA fiber, Fibre optic polarizer, attenuator, copler and polarization splitter, Gaussian beam, Bessel beam, Brewster angle, GRIN lens, Fiber Bragg grating, Long fiber Bragg grating, Bragg reflection, Dispersion, Types of dispersion. Distributed fiber optic sensors: OTDR and OFDR principles in temperature measurement, Stress, strain and temperature measurement using fiber optic sensors, Microbend sensor, Fiber optic gyroscope : Principle and applications, Bicolour thermometry. Fiber optic gyro holographic measurement and its biomedical applications, Optoelectronic integrated circuit and integrated optics sensor, Optoelectronics sensors and system: sensor as a modulator, bulk modulator, fibre optic modulator. Sensing principles: electro-optic and magneto-optic (polarimetric and interferometric), magneto-striction based sensors.

Text Book:
1. G. P. Agrawal, Fiber-Optic Communication System, 3rd Edition, Wiley StudentEdition
2. Amnon Yariv, PochiYeh , Photonics: optical electronics in modern communications, 6th edition, Oxford UniversityPress.

Reference Book:
1. C. K. Sarkar, Opto Electronics And Fibre Optics Communication, New Age International (P)Ltd
2. Clifford R. Pollock, Fundamentals of optoelectronics,Irwin

8. High Voltage Engineering

Breakdown phenomenon: breakdown in gases - mechanism of breakdown in gases, Townsend's ionization coefficients, Paschen's Law, time lags for breakdown, streamer breakdown theory. Breakdown in liquids - suspended solid particle mechanism, cavitation and bubble mechanism, stressed oil volume mechanism, etc. Breakdown in solids - intrinsic breakdown, electromechanical breakdown, breakdown of solid dielectrics in practice, chemical and electrochemical deterioration and breakdown, breakdown due to treeing and tracking, breakdown due to internal discharges.
Basic idea about protection against overvoltage - lightning arresters, surge absorbers, ground wire, grounding practices etc. BIL, SIL of the equipments, v-t curve, concepts of insulation coordination.
Generation of high ac & dc voltage: high ac voltage generation – testing transformer and its cascaded connections. Single phase resonant circuits. High dc voltage generation - single stage and multi stage voltage multiplier circuits.
Impulse voltage and current generation: introduction to impulse current and voltage, impulse generator circuits, analysis of circuit "a" and "b".
Measurement of high voltage and current : electrostatic voltmeter, Chubb and Fortescue method of measuring peak value of a.c., sphere gap method, rod gap method of measuring high voltage, impulse voltage measurement using potential dividers, impulse voltage and current measurement using CRO.
High voltage testing: Testing of overhead line insulators, bushing, power transformer, circuit breakers, Testing of transformer oil, loss in dielectric, measurement of resistivity, dielectric constant and loss factor.

Text Books:
1. C. L. Wadhwa, High Voltage Engineering.
2. M.S Naidu & V Kamaraju , High Voltage Engineering.

Reference Books :
1. E. Kuffel and WS Zaengl, High Voltage Engineering-Fundamentals, Pergamon Press.
2. Alston , High Voltage Technology , Oxford University Press.

Courses Objective:

1: Understand breakdown phenomena in gases, liquids and solids. To understand effects of non-uniform fields, partial breakdown and corona.
2: Elucidate different methods used for the generation of high voltages and currents of power frequency and impulse.
3: Elucidate the concepts used for the measurement of high voltages and currents and design corresponding circuits.
4: Understand high voltage testing techniques for different dielectric material and Power apparatus.
5: Understand causes of over voltages in Power systems. Design the layout of substations and to know the concepts of insulation coordination.

Course content :

Unit 1: Introduction, Electric Fields, Breakdown of gaseous medium

The purpose and objective of studying HVE. Introduction to the subject. Voltage Levels, Uniform and non-uniform fields, Electrical Insulations and Dielectrics, breakdown phenomenon of gaseous medium, electronegative gases, corona.

Unit 2:Breakdown in Liquid and Solid

Liquids as insulators, different liquids, major characteristics influencing dielectric properties. Different theories for breakdown: suspended particle, cavity theory, thermal and electro-convection mechanisms. Different solid dielectrics commonly used in practice. Different breakdown mechanisms in solid dielectrics: intrinsic, electromechanical, treeing and tracking, thermal, electrochemical and internal discharges.

Unit 3:Generation of High Voltages

Methods of generation of Power Frequency high voltage: HV low power transformers, Cascaded transformers, Resonance Transformers. Generation of high DC voltage: Multistage Cockroft-Walton Voltage Multiplier, Ripple and Regulation. Impulse Generator: Analysis of Single Stage Circuit, Multistage Impulse Generator, Triggering Methods.

Unit 4:Measurement of High Voltage

Potential Dividers, their types and applications. Measurement of ac and dc. AC Peak and RMS High Voltage measurement techniques using: sphere gap breakdown, rod gap breakdown, CVT, Electrostatic Voltmeter. Impulse Voltage measurement using CRO. Measurement of currents: Hall Sensor, Electro-optical Sensor.

Unit 5: High Voltage Testing

Measurable properties of dielectrics: dc resistivity, dielectric constant, loss factor. Measurement of Dielectric properties with HV Schering Bridge, Wagner earthing. HV Testing of equipment and apparatus: Type tests and Routine tests, Different common tests.

Unit 6: Overvoltages in Power Systems and Insulation Coordination

Internal: System transients, Arcing ground. External: Lightnings: Different theories for lightning: Wilson theory, Simpson theory. Insulation Coordination and overvoltage Protection: BIL - SIL, V-t Curve, Horn gap, Surge diverter, Shield wire.

Course Outcome :

After successful completion of the course the students will be able to:

1. Understand breakdown phenomena in gases and to elucidate the concepts used for the generation of high voltages and currents.
2. Elucidate the techniques used for the generation and measurement of high voltages and currents in Lab from available 415/240 V source.
3. Understand high voltage testing techniques of Power apparatus and causes of over voltage in Power systems.
4. Understand the layout of high voltage substations and to know the concepts of overvoltage protection and insulation coordination.

9. <u>Electrical Machine Design</u>

Designing an electrical machine – a paradigm shift from studying an electrical machine; converting & expressing electrical quantities and equations involving length, breadth, cross-section, etc, specifications for commencing a design; the three major sub-areas: electromagnetic, thermal & mechanical; use of empirical formulas, use of assumed constants, lack of clear mathematical relations make designing a repetitive task; no optimum but optimal design; use of computers. Transformer: initial values to be assumed, core design, window dimension design, yoke design, overall dimension design, LV winding design, HV winding design, checking the design output with specification: calculation of resistance, reactance, losses, efficiency, regulation, no load current, designing cooling system. Rotating machine: general concepts and constraints in design of rotating machines; output equation in terms of main dimensions, specific magnetic & electric loadings and speed; factors affecting the size of machines; choices of both specific loadings; separation of D & L for different types of machines. Output equation of induction motor – choice of average air gap flux density – choice of ampere conductor per metre - main dimensions –stator winding design – stator slots design – stator teeth & core - rules for selecting rotor slots of squirrel cage machines – design of rotor bars & slots – design of end rings – design of wound rotor -– magnetic leakage calculations – leakage reactance of poly phase machines- magnetizing current - short circuit current – circle diagram - operating characteristics.

Text Books:

1. M G Say, Performance and Design of ac machines, CPS Publishers
2. S. K. Sen, Principles of Electrical Machine Design with Computer Programmes, Oxford and IBH Publishing Co. Pvt Ltd.

Reference Books:

1. R.K. Agarwal, Principles of Electrical Machine Design, S.K.Kataria & Sons
2. A.K. Sawhney, A Course in Electrical Machine Design, 6th edition, Dhanpat Rai and Sons

Courses objective:

1. To understand the significance of magnetic flux, magnetic circuits with and without airgaps for electrical machines
2. To design inductors and small transformers for different applications: DC-DC Converters, Fluorescent lamp choke, Power supply set.
3. To do magnetic designs for a three phase transformer to find all details of core
4. To do electrical designs to determine no of turns, selection of conductors, type of windings. To compute performances of the design done with respect to full load losses, no load current, etc. and to compare with the specifications and hence to decide about where and how much modifications are necessary for improving performances to match specifications
5. To do thermal design by deciding cooling method required and to design that
6. To study the basics of design of rotating machines with designing main dimensions of a three phase Induction Motor.

Course content :

Unit- 1 Introduction:

Comparison of studying Electrical Machines and studying Electrical Machine Design. Machine Design involves all activities required to manufacture a machine from **required data** as given by the customer's specifications. Machine design is a team work and needs interactions and cooperation within a team and among teams.

Unit- 2 Revisiting magnetic circuit analysis:

Revisiting magnetic circuit analysis for ampere-turns, core flux, and air-gap flux. Designing **Inductors** for different applications like DC-DC Converters and Fluorescent lamp choke

Unit- 3 Magnetic design of a transformer:

Magnetic design of a transformer: choice of core material and maximum flux density, designing emf per turn, no. of turns of all windings, to design main dimensions, window details – deciding height and width of windows, core and yoke design, use of laminations and stepped designs. Use computers for computations

Unit- 4 Electric designs of a transformer:

Designing winding types, choice of current densities and selection of conductor cross-section areas and determining bare sizes and sizes after insulation, Finally refining current densities with final sizes, verifying window area free space with designed conductor sizes, finding resistances and leakage reactances of windings, estimating possible regulation, losses and efficiency with designed data and to verify whether they are within the limits of specification. To redo the parts of designs in cases of limit violations. Use computers for computations

Unit– 5 Thermal designing:

Different types of cooling e.g. ONAN, ONAF, etc., different classifications of insulations based on temperature, Designing tank size, designing extra cooling surface required and designing cooling tubes, checking temperature rise and to **keep** it below the specified value. Use computers for computations

Unit – 6 Introduction to rotating machine designing:
Introducing three phase Induction Motor design, Specific magnetic loading and current loading. Determining main dimensions, Differences in flux distribution due to air-gaps, armature slots and teeth, flux density concentration at teeth, dependence of specific loadings on main dimensions, separation of D and L, Standard frames and choice of frames.

Course Outcome :
After successful completion of the course the students will be able to:
1. Design and fabricate small items like inductors and small transformers for different applications.
2. Prepare specifications necessary to purchase an Electrical Machine.
3. Design a Transformer from the buyer's specifications.
4. Design an Induction Motor from the buyer's specifications.

10. Advanced Power Electronics

Analysis of ac to dc, dc to ac, dc to dc converters; applications of state space averaging techniques, small signal modelling, control issues. Switched mode rectifier- operation of single/ three phase bilateral bridges in rectifier mode. Design of high frequency transformers and inductors. Introduction to resonant converters, Classification of resonant converters, Basic resonant circuit concepts, Load resonant converter, Resonant switch converter. Zero voltage switching, zero current switching, clamped voltage topologies.

Text Book:
1. Robert W. Ericson, Fundamentals of Power Electronics, Chapman &Hall
2. Ned Mohan, Undeland and Robbin, Power Electronics: converters, Application and design, John Wiley andsons.
3. L. Umanand, Power Electronics: essentials and application,Wiley

Reference Book:
1. Bose, Bimal K, Power Electronics and AC Drives, Prentice-HallIndia

11. Optical Engineering and Laser Instrumentation

Optical fields and waves-their interaction with bulk and structured matter: Engineering principles for optical materials, components and systems. Laser and their related technologies, Principle and devices on electro-optic effect: **Phase and amplitude modulation**, acousto-optic: **A.O. diffraction, modulators, deflectors** and magneto-optic effect, Guided wave optics and harmonic generation, Methods of Q switching and mode locking, Ultrashort pulse generation, Laser based methods and systems for measurement and sensing, interferometry, holography, speckle, fibre and Fourier optics.

Text Book:
1. **AmnonYariv**, PochiYeh, Optical waves in crystals: propagation and control of laser radiation,Wiley.
2. Orazio Svelto , Principles of Laser, Springer.

Reference Books
1. P Das , Laser And Optical Engineering,Springer
2. G. P. Agrawal , Nonlinear Fiber Optics , Academic Press.

Course Objective:

1. To expose the students to the basics concepts of Optics.
2. To introduce with different types of Electro optic effects.
3. Analyze the operation of Electro optic modulators and apply in optical systems.
4. To understand the phase matching concept along with harmonic generation.
5. To expose the students to the basics fundamentals of LASER.
6. To provide adequate knowledge about the applications of LASER in different fields.

7. To understand the interaction process of optical wave with bulk and structured matter.
8. To expose the students to the basics fundamentals of polarization.
9. Explain the principle of Q-switching and mode locking.
10. To understand the method of pulse generation.
11. Explain the fundamentals of different type of scattering.

Course content :
Unit- 1
Basic Fundamental of Optics :
Overview of basic optics.
Isotropic and Anisotropic medium.
Types of crystals : Uniaxial crystal and Biaxial crystal
Different types of polarization : P polarization, S polarization
Refractive Index : ordinary and extra ordinary.
Second Harmonic Generation
SFG, DFG, OPG
Conversion efficiency
Phase matching : Critical and Non-critical
Quasi-Phase Matching
Unit – 2
Principle of electro-optics:
Fundamental of Electro–optic effect.
Types of Electro–optic effect: Linear electro–optic effect, Non-linear electro–optic effect, Quadratic electro–optic effect, Kerr Effect.
Index Ellipsoid , Jones calculus, Miller calculus.
Energy density w.r.t EOE.
EOE in 3-axis system with electro-optic tensor.
Linear electro–optic effect in uniaxial crystal.
Linear electro–optic effect in biaxial crystal.
Linear electro–optic effect in isotropic crystal.
Electro–optic co-efficient for different types of materials.
Unit – 3
Devices based on electro-optics:
Electro-Optic Modulator.
Classification of EO Modulator:
Phase Modulator
Amplitude Modulator
Polarization Modulator
Transverse EO Modulator
Mach-Zehnder Modulator
Travelling wave Modulator
Unit – 4
Lasers and their related technologies:
Working principal of Laser.
Types of Lasers.
3- level laser and 4-level laser
Absorption and Emission

Spontaneous Emission
Stimulated Emission
Application of different types of lasers.

Unit – 5

Optical fields and waves:

Optical waves- their interaction with bulk and structured matter.
Birefringence : Natural and Induced.
Focusing & Defocusing.
Gauss law of electric fields
Vector magnetic potential.
Interaction of light with metal
Optical rectification

Unit-6

Methods of Q-switching :

Q-switching : Active and Passive.
ON Q-switching ,OFF Q-switching, EO Q-switching.
Peak Power and Intensity of Laser.
Different types of Polarization.
Applications of Q-switched Laser.
AOE Q-switching

Unit – 7

Ultra short pulse generation:

Average energy of pulse.
Grade index lens
Intensity dependent refractive index
Soliton : temporal and Spatial
Self phase modulation
Selp induced chirp
Cross phase modulation
Optical bistability
modulation intensity.

Unit – 8

Mode locking Technique:

Fundamental of mode locking
Kerr lens Mode locking
Non-linear mirror mode locking
Non-linear cascade mode locking
Saturable Absorber

Unit – 9

Optical Scattering:

Raman scaterring
Stimulated raman scattering
Brillouin scaterring
Stimulated brillouin scattering
Stokes and Anti-stokes Scattering

Course outcome :

1. Students learn basic laser theory, and the the necessary components and control systems that are necessary for lasers to be useful in modern optical communication systems. Student’s ability to analyse performance of different type electro-optic modulators.

2. Student's ability to design different cavity as per requirement.
3. Students learn how to calculate the peak power and intensity of pulse.
4. Students are given opportunities to observe the impact of modern telecommunication systems on society.
5. Student's ability to do simulation of particular problem through MATLAB.
6. Student's ability to write a good technical report.

12. Renewable Energy Technology

Energy resources, reserve and availability of Oil, gas and coal in global and national context. Environmental constraints of traditional non-renewable sources. Renewable Energy: need for accelerated growth, Technologies for electricity generation: Solar energy: solar fundamentals, solar energy resources, solar PV system: components, types, design, and applications; Thermo solar systems. Wind energy system: wind energy conversion and devices, power from the wind, wind energy and environment. Hydro electric system: classifications, concepts, benefits of hydel power generation. Tidal energy system: free-flow and dam-type, evaluation of tidal energy. Biomass energy generation; Geothermal power plants. Energy storage and Energy management.

Text Book:
1. B.H. Khan, *Non-Conventional Energy Resources*, McGraw Hill.
2. J. Andrews, N. Jelley , *Energy Science Principles, Technologies and Impact*, Oxford University Press.

Reference Books:
1. D.S. Chauhan, S.K.Srivastava , *Non Conventional Energy Resources*, New Age Int.(P)Ltd.
2. P. Gevorkian , *Sustainable Energy Systems Engineering* , McGraw Hill.

Courses objective:

1. Develop knowledge about the different renewable energy sources, energy conversion devices and their technologies.
2. Characterizations and modeling of different renewable energy sources and performance evaluation of the systems.
3. Design and integration of renewable energy systems.
4. Relate the different energy generation technologies with other engineering subjects to extend the boundary of research areas.

Course content:

Unit- 1
Energy Resources: Terminology, Major Energy Resources in use: Resource, Reserve and Availability of Oil, Gas and Coal in global and national context. Energy Consumption Demand:
Unit 2
Renewable Energy: Need for accelerated growth: availability and environmental constraints of traditional non-renewable sources. Demerits of Solar sources. PV Technologies for electricity generation
Unit – 3
Wind Power plants. Hydroelectricity
Unit – 4
Biomass; Tidal and Geothermal power plants**,** Energy Storage
Unit – 5
Energy Management and Audit

Course outcome:

1. Student's ability to understand the energy scenario in national and global level.

2. Student’s ability to understand the fundamentals of various renewable resources and systems.
3. Student’s ability to analyse performance of renewable energy systems.
4. Student’s ability to design energy projects.
5. Student’s ability to identify the problems in the subject domain.
6. Student’s ability to understand the energy policy and energy security issues.
7. Student’s ability to understand environmental and sustainability issues of energy sector.

13. Solar Photovoltaic Systems

Solar cells, solar PV modules, PV module output as function of temperature and solar radiation, solar geometry, availability of solar radiation at a given location, solar PV systems and components, solar PV water pumping system, introduction to power electronic devices, off-grid and grid-connected PV systems, charge controller, DC-DC converter, DC-AC inverter, maximum power point tracking, energy storage options for solar PV systems, design of off-grid PV systems, design of grid-connected PV systems, hybrid PV Systems, life cycle costanalysis.

Text Book:
1. R.A. Messenger, J. Venture , Photovoltaic Systems Engineering, CRC Press.
2. R. Foster, M. Ghassemi, A. Cota, Solar Energy , CRC Press.

Reference Book:
1. S.P. Sukhatme , Solar Energy , Tata McGraw Hill.
2. C.S. Solanki , Solar Photovoltaics, Printace Hall of India.

14. Network Synthesis

Positive real function –synthesis of 2 port, R-L-C networks, cascading and interconnection, bisection theorem, synthesis of R-L and R-C filters-Butterworth, Chebyschev, Bessel type frequency transformations. Active networks and synthesis techniques. Synthesis of R-L-C, low pass, high pass, band pass and band reject filters. Biquad and simulation of physical systems and activenetworks.

Text Book:
1. Kuo, Franklin F, Network Analysis and Synthesis, John Wiley and sons, Singapore,1966.
2. D Roy Chaudhury, Network Analysis and Systems, New Age International, New Delhi,1996.
3. Rolf Schaumann, Mac E Van Valkenburg,Design of Analog Filters, Oxford University Press, 2001.

Reference Book:
1. M.E. Van Valkenburg, An Introduction to Modern Network Synthesis ,Wiley. Eastern Ltd..
2. Harry Y. F. Lam , Analog and digital filter design and realization, Prentice Hall

15. Embedded Systems

Introduction to Embedded Systems; Embedded Systems Hardware: Processors - Digital Signal Processors, Microcontrollers, Special Purpose Processors, I/O devices, interfacing and control - Analog I/O, Digital I/O, Bus I/O, Serial and Network I/O, Memory, Power and Display Devices - Reconfigurable and Custom Logic Devices, System Hardware Design Case Study; Embedded Systems Software : Introduction to Operating Systems, Real Time Operating Systems, Device Drivers; Embedded Systems Application Design and Programming Environments : System Specification and Modelling, Programming, Simulation and Verification, Performance Analysis and Optimisation; Selected Application Case Studies from areas such as : Instrumentation and Signal Processing Systems, Control and Actuation Systems, Power Electronic Drive Systems etc; Embedded Systems Testing.

Text/ Reference Books:

1. Santanu Chattopadhyay, "Embedded System Design", PHI Learning Pvt.Ltd.
2. Andrew N. Sloss, Dominic Symes, Chris Wright. "ARM System Developers Guide: Designing and Optimizing System Software", Elsevier
3. Richard Barnett, Larry O'Cull, Sarah Cox, "Embedded C Programming and the Microchip PIC", Delmar Cengage Learning.
4. P Lapsley, DSP Processor Fundamentals -Architecture and Features, Chand Publications
5. Hamid.A.Toliyat and Steven G.Campbell, "DSP Based Electro Mechanical Motion Control", CRC Press New York,2004
6. Wayne Wolf," FPGA based system design ", Prentice hall,2004.
7. Real-time Systems - Jane Liu, PH2000.

16. Pulse Width Modulation Technique

Purpose of Pulse Width Modulation, Low switching frequency Pulse width modulation, Selective harmonic elimination, offline optimized pulse width modulation. Sine-triangle pulse width modulation, Harmonic injection pulse width modulation, Bus clamping pulse width modulation.Space Vector based PWM: Concept of space vector, Conventional space-vector PWM, Space vector based bus clamping PWM, Space vector based advanced bus clamping PWM.Harmonic analysis of PWM technique, Analysis of RMS line current ripple. Analysis of DC link current and DC capacitor current in a VSI.Evaluation of conduction loss and switching loss in three phase inverter, Design of PWM for reduced switching loss in three phase inverter.Effect of dead time on inverter output voltage for continuous PWM scheme and bus-clamping PWM scheme.Over-modulation in sine-triangle PWM inverter and in space vector modulated inverter.PWM for three level neutral point clamped inverter

Text/ Reference Books:

1. D. Grahame Holmes, Thomas A. Lipo, "Pulse width modulation of Power Converter: Principles and Practice", John Wiley & Sons.
2. Bin Wu, "High Power Converters and AC Drives", John Wiley & Sons Publication.

Courses objective:

1. To understand operation of different PWM converters.
2. To acquire in depth knowledge regarding step by step implementation of various PWM methods for VSIs.
3. To learn the effect of various PWM methods.
4. To explore the possibilities of modifying PWM for better efficiency of PE converters.
5. To analyse and compare various conventional PWM methods for VSIs.

Course content :

Unit- 1

Overview of the PE Converters: Electronic Switches and their V-I characteristics, Basic Operation of DC-DC converters, DC-AC converters, Multilevel Converters, Purpose of PWM, Application of Voltage Source Converters.

Unit - 2

Low Switching Frequency PWM: One switching per quarter, Two switching per quarter, Selective Harmonic elimination, Off line pulse width modulation.

Unit – 3

Triangle comparison PWM: Sine Triangle PWM, Harmonic injection PWM, Bus Clamping PWM etc. For 1-phase and 3-Phase VSI and three level NPC.

Unit – 4
Space vector based PWM : Concept of Space vector, Conventional SVPWM , Conduction loss, DC Link current calculation, Analysis of line current ripple, Effect of dead time.
Unit – 5
Other PWMs in perspective of Space Vector PWM : Space Vector based 60 degree Bus Clamping PWM, Space Vector based 30 degree Bus Clamping PWM, Continual Clamp and Split Clamp PWM, Space vector based Advanced Bus Clamping PWM.

Course outcome:

1. Understand the working principle and application of various PWM converters.

2. Understand the implementation process of various PWM methods

3. Calculate the switching time duration of single and three phase VSI for different PWM methods.

4. Learn the advantages and disadvantages of various PWM methods applicable to VSI.

5. Evaluate the performance of various PWM methods applicable to VSI.

17. Power System Protection

Basic concepts of power system protection, overview of over current, distance, directional, differential protection. Protection of generators, transformers, bus bars and transmission lines. Distance protection. Computer relaying. Induction motor protection, Digital relays, Microprocessor based relay. Protection of distribution DG, special protection scheme. Phasor estimation, wide area protection.

Course Content:

Unit I Introduction
Importance of protective schemes for electrical apparatus and power system .Qualitative review of faults and fault currents –relay terminology –definitions –and essential qualities of protection . Protection against over voltages due to lightning and switching –arcing grounds-Peterson Coil-ground wires-surge absorber and diverters Power System earthing, neutral Earthing- basic ideas of insulation coordination .
Unit II Operating Principles and Relay Characteristics
Electromagnetic relays-over current, directional and non- directional, distance, negative sequence and differential and under frequency relays –Introduction to static relays.Fundamental principles of protective relays , their properties and block diagrams .Single input relays , over current , earth fault and over voltage relays .Principle and application of directional over current and earth fault relays .Principle of 2-input comparison ,two and multi input comparators . Distance relays & their settings, errors and remedies to errors .Differential relays current and voltage comparison.
Unit III Apparatus Protection
Main considerations in apparatus protection –transformer, generator and motor protection –protection of busbars. Transmission line protection –zones of protection .CTs and PTs and their applications in protection schemes.
Unit IV Theory of Circuit Interruption
Physics of arc phenomena and arc interruption .DC and AC circuit breaking-re-striking voltage and recovery voltage –rate of rise of recovery voltage – resistance switching –current chopping –interruption of capacitive current.
Unit V Circuit Breakers
Types of circuit breakers –air blast, air break, oil, SF6 and vacuum circuit breakers-comparative merits of different circuit breakers –testing of circuit breakers.Auto re-closing feature –three pole & single pole auto

re-closing. Protective relays ,circuit breakers and switchgear are items of an equipment with which every power engineer has to deal with in the course of his / her professional career .This course will be very useful to students preparing for professional examinations as well as to practicing engineers engaged in systems protection work .

Course outcome:

On successful completion of the course, the students will be able to
1.understand the fundamentals of protection for electrical apparatus and switchgear.
2.understand the operating principles of relay characteristics
3.have a detailed knowledge about the protection of different apparatus.
4.have an analytical study of the theory of circuit breakers for application purpose.
5.have a detailed knowledge about the interruption of circuit breakers.
6.understand the practical application and testing and various precautionary measures of protective devices with a view to applying the knowledge to solve practical problems.

18. Smart Grid Fundamentals with Renewable Integration

The Smart Grid: Introduction, Why implement the Smart Grid now, Ageing assets and lack of circuit capacity, Thermal constraints, Operational constraints, Security of supply, National initiatives, What is the Smart Grid?, Early Smart Grid initiatives, Active distribution networks, Virtual power plant, Other initiatives and demonstrations, Overview of the technologies required for the Smart Grid.

Introduction to Smart Grid Applications: Introduction, Voltage and Var Control and Optimization, Devices for Voltage and Var Control, Voltage Drop and Energy Loss in Distribution System, Load Response to Voltage Variations, Benefits Potential of Voltage and Var Control Approaches, Communication Requirements, Inclusion of New Controllable Resources, Interaction with Applications, Fault Detection, Isolation and Restoration (FDIR), Drivers and Benefits of FDIR, Field- Based FDIR Schemes, Control Centre Based FDIR Schemes, Reliability: Present and Future, Demand Response (DR), Types of DR Programs, Communication requirement, Statistical Reliability of Demand Response.

Smart Grid Monitoring and Control: Distributed Energy resources (DERs), Operation and Control, Communication Requirements, Sustainable Power Grid, Wide- Area Monitoring, Control and Protection (WAMCP), Structure of WAMCP system, Overview of WAMCP Application, Stabilizing and Emergency Control Actions, Implementation Aspects of WAMCP Systems.

Smart Grid Communications And Measurement Technology: Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Phasor Measurement Units (PMU), Smart Meters, Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Multiagent Systems for Smart Grid Implementation, Multiagent Specifications, Multiagent Technique, Microgrid and Smart Grid Comparison

Performance Analysis Tools For Smart Grid Design: Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, Contingencies and Their Classification, Contingency Studies for the Smart Grid.

Stability Analysis Tools For Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.

Computational Tools For Smart Grid Design: Introduction to Computational Tools, Decision Support Tools (DS), Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational

Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges

Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Solar Energy , Solar Power Technology, Modeling PV Systems, Wind Turbine Systems, Biomass-Bio energy, Small and Micro Hydropower , Fuel Cell, Geothermal Heat Pumps, Penetration and Variability Issues Associated with Sustainable, Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, HEV Technology, Impact of PHEV on the Grid, Environmental Implications, Climate Change, Implications of Climate Change, Storage Technologies.

Reference Books:

1. Smart Grid: Fundamental of Design and Analysis By James Momoh- Wiley Publication

2. Smart Grid Technology and Application By Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins- Wiley Publications

Courses objective:

1. To understand the smart grid initiatives and technology requirements in existing power system network.
2. To understand smart grid monitoring, control and applications in terms of demand side integration.
3. To acquaint with different communication and measurement technologies involved with smart grid namely: LAN, HAN, NAN, WAMCP, Smart Meter, AMI, PMUs and IEDs etc.
4. To analyze performance analysis tools in term of load flow studies, congestion management and contingency studies.
5. Introduction to brief ideas about renewable energy and storage. HEV, PHEV and its impact on grid, climate change etc.

Course content:

Unit- 1 Introduction:
The Smart Grid: Introduction, why implement the Smart Grid now, Ageing assets and lack of circuit capacity, Thermal constraints, Operational constraints, Security of supply, National initiatives, What is the Smart Grid, Early Smart Grid initiatives, Active distribution networks, Virtual power plant, Other initiatives and demonstrations, Overview of the technologies required for the Smart Grid.

Unit- 2 Introduction to Smart Grid Applications:
Introduction, Voltage and Var Control and Optimization, Devices for Voltage and Var Control, Voltage Drop and Energy Loss in Distribution System, Load Response to Voltage Variations, Benefits Potential of Voltage and Var Control Approaches, Communication Requirements, Inclusion of New Controllable Resources, Interaction with Applications, Fault Detection, Isolation and Restoration (FDIR), Drivers and Benefits of FDIR, Field- Based FDIR Schemes, Control Centre Based FDIR Schemes, Reliability: Present and Future, Demand Response (DR), Types of DR Programs, Communication requirement, Statistical Reliability of Demand Response.

Unit- 3 Smart Grid Monitoring and Control:
Distributed Energy resources (DERs), Operation and Control, Communication Requirements, Sustainable Power Grid, Wide- Area Monitoring, Control and Protection (WAMCP), Structure of WAMCP system, Overview of WAMCP Application, Stabilizing and Emergency Control Actions, Implementation Aspects of WAMCP Systems.

Unit- 4 Smart Grid Communications and Measurement Technology:
Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Phasor Measurement Units (PMU), Smart Meters, Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Multiagent Systems for Smart Grid Implementation, Multiagent Specifications, Multiagent Technique, Microgrid and Smart Grid Comparison

Unit– 5 Performance Analysis Tools for Smart Grid Design:
Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, Contingencies and Their Classification, Contingency Studies for the Smart Grid.

Unit– 6 Stability Analysis Tools for Smart Grid:
Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.

Unit– 7 Computational Tools for Smart Grid Design:
Introduction to Computational Tools, Decision Support Tools (DS), Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges

Unit– 8 Renewable Energy and Storage:
Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Solar Energy , Solar Power Technology, Modeling PV Systems, Wind Turbine Systems, Biomass-Bio energy, Small and Micro Hydropower , Fuel Cell, Geothermal Heat Pumps, Penetration and Variability Issues Associated with Sustainable, Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, HEV Technology, Impact of PHEV on the Grid, Environmental Implications, Climate Change, Implications of Climate Change, Storage Technologies.

Course outcome:
After successful completion of the course the students will be able to:
1. Understand the smart grid initiatives and technology requirements in existing power system network.
2. Understand smart grid monitoring, control and applications in terms of demand side integration.
3. Will be familiar with different communication and measurement technologies involved with smart grid namely: LAN, HAN, NAN, WAMCP, Smart Meter, AMI, PMUs and IEDs etc.
4. To be able to analyze performance analysis tools in term of load flow studies, congestion management and contingency studies.
5. Will be introduced to brief ideas about renewable energy and storage. HEV, PHEV and its impact on grid, climate change etc.

19. Artificial Intelligence and Expert System

Expert Systems (ES): Major Characteristics of expert systems, techniques, rule-based expert systems, knowledge acquisition, applications.
Fuzzy Logic (FL): Fuzzy set theory, fuzzy inference, fuzzy logic expert system, fuzzy control.
Neural Networks (NS): Artificial neurons and neural networks, Learning process: error-correction learning, Hebbian learning, Boltzmann learning, Competitive learning, Supervised/ unsupervised learning, Perception and multilayer perception, Self-organising Kohonen networks, Hopfield neural networks, practical implementation and applications.
Genetic Algorithms (GA): adaptation and evolution, a simple genetic algorithm, genetic algorithms in optimization, genetic algorithms in controls.

Text/ Reference Books:

1. Michael Negnevitsky, "Artificial Intelligence: A guide to Intelligent Systems", Oxford University Press.
2. M. Gopal, "Digital Control and State Variable Methods, Conventional and Neuro-Fuzzy Control System", Oxford University Press.
3. Staurt Russel and Peter Norvig, "Artificial Intelligence- A modern approach", PHI.
4. Patrick Henry Winston, "Artificial Intelligence", 3rd Ed., Addition Wesley.
5. S. Haykin, "Neural Networks: A comprehensive Foundation", Pearson.

20. Advanced Control Systems

Introductory matrix algebra and linear vector space. State space representation of systems, Linearization, Solution of state equations, Evaluation of state transition matrix(STM).Simulation of state equation using MATLAB ,SIMULINK program, Similarity transformation and invariance of system properties due to similarity transformations, Minimal realization of SISO,SIMO, MISO transfer function .Discretization of a continuous time state space model. Convert state space model to transfer function model using Fadeeva algorithm .Fundamental theorem of feedback control, Controllability and Controllable canonical form .Pole assignment by state feedback using Ackermann's formula, controllable canonical form and numerically stable method based on controllable Hessenberg form. Eigen structure assignment problem. Linear Quadratic Regulator (LOR) problem and solution of algebraic Rieeati equation using eigen value and eigenvector methods, iterative method, and numerically stable algorithm .Controller design using output feedback. Observability and observable canonical forms. Design of full order observer using Ackermann's formula, observable canonical form, observable Hessenberg canonical form and Bass Gura algorithm, Duality. Observer based controller design. Reduced order observer design. 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 Model decomposition and Decoupling by state feedback. Disturbance rejection, sensitivity and complementary sensitivity functions, internal model control (IMC).

Text/Reference Books:-

1. Norman N. Nise, "Control Systems Engineering",10th Edition wiley & son
2. B .C Kuo, "Automatic Control Systems", 4th Edn., Prentice Hall of India.
3. W . A Wolowich, "Automatic control systems, basic analysis and design".
4. K . Ogata,"Modern Control Engineering" ,5th Edition., Prentice Hall.