Course Curriculum

(Course Structure and Syllabi)

for

Bachelor of Technology

in

Electrical Engineering

(Second Year Onwards)

Department of Electrical Engineering

National Institute of Technology Hamirpur

Hamirpur – 177 005 (India)

Second Year												
3rd Semester							4th Semester					
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	MA-203	Engineering Mathematics-III	3	1	0	4	1	HS-203	Organizational Behaviour	3	0	0	3
2	EE-211	Network Analysis and Synthesis	3	1	0	4	2	EE-221	Electrical Machines-I	3	1	0	4
3	EE-212	Electromagnetic Field Theory	3	1	0	4	3	EE-222	Microprocessor Architecture and Interfacing	3	1	0	4
4	EE-213	Electrical and Electronic Measurements	3	0	0	3		EE-223	Power Electronics	3	1	0	4
5	EC-211	Digital Electronics and Logic Design	3	1	0	4	5	EE-224	Power System	3	1	0	4
6	EE-214	Network Analysis and Synthesis Lab	0	0	2	1	6	EE-225	Electrical Machines-I Lab	0	0	2	1
7	EE-215	Electrical and Electronic Measurements Lab	0	0	2	1	7	EE-226	Power Electronics Lab	0	0	2	1
8	EC-214	Digital Electronics and Logic Design Lab	0	0	2	1	8	EE-227	Microprocessor Architecture and Interfacing Lab	0	0	2	1
		Total Hours = 25				22			Total Hours = 25				22

Third Year												
5th Semester							6th Semester					
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	EE-311	Protection and Switchgear	3	1	0	4	1	EE-321	Control Engineering	3	1	0	4
2	EE-312	Electrical Machines–II	3	1	0	4	2	EE-322	Power System Analysis	3	1	0	4
3	EE-313	Signals and Systems	3	1	0	4	3	EE-323	Digital Signal Processing	3	1	0	4
4	EE-314	Transducers and Signal Conditioning	3	0	0	3	4	EE-324	Electric Drives	3	0	0	3
5	OET	Open Elective-I	3	0	0	3	5	OET	Open Elective-II	3	0	0	3
6	EE-315	Power System Protection Lab	0	0	2	1	6	EE-325	Control Engineering Lab	0	0	2	1
7	EE-316	Electrical Machines-II Lab	0	0	2	1	7	EE-326	Power System Analysis Lab	0	0	2	1
8	EE-317	Transducers and Signal Conditioning Lab	0	0	2	1	8	EE-329	Seminar	0	0	2	1
		Total Hours = 24				21			Total Hours = 24				21

Fourth Year												
7th Semester							8th Semester					
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	HS-404	Engineering Economics and Accountancy	3	0	0	3	1	EE-421	High Voltage Engineering	3	0	0	3
2	EE-411	Modern Control Systems	3	0	0	3	2	EE-422	Communication Systems	3	0	0	3
3	DET	Professional Elective-I	3	0	0	3	3	DET	Professional Elective-III	3	0	0	3
4	DET	Professional Elective-II	3	0	0	3	4	DET	Professional Elective-IV	3	0	0	3
5	EE-418	Industrial Training Presentation	0	0	2	1	5	EE-428	General Proficiency	0	0	0	1
6	EE-419	Major Project (Stage-I)	0	0	12	6	6	EE-429	Major Project (Stage-II)	0	0	12	6
		Total Hours=26				**19**			**Total Hours =24**				**19**

Semester Wise Credits									
Semester	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**Total**
Credits	24	24	22	22	21	21	19	19	**172**
Hours/week	28	28	25	25	24	24	26	24	**204**

Professional Elective Courses

Professional Elective-I (courses related to tools/techniques)

EE-430	Neural Networks and Fuzzy Logic
EE-431	Optimization Methods in Engineering
EE-432	Probability, Random Variables and Stochastic Processes
EE-433	Process Modeling and Control

Professional Elective-II (courses related to Control System)

EE-450	Design of Feedback Control Systems
EE-451	Advanced Microprocessor Systems and Microcontroller
EE-452	Optimal Control Theory
EE-453	Power Quality and Harmonics

Professional Elective-III (courses related to Power System)

EE-440	Power System Operation and Control
EE-441	Reactive Power Control and FACTS Devices
EE-442	Deregulation of Power System
EE-443	Design of Hydro Power Station

Professional Elective-IV (courses related to Electrical Machines and Drives)

EE-460	Transformer Engineering
EE-461	Advanced Electrical Machines
EE-462	Advanced Power Electronics
EE-463	Electrical Machine Design

Open Elective Courses

Open Elective-I

EE-370	Neural Networks and Fuzzy Logic Systems
EE-371	Elements of Control System

Open Elective-II

EE-380	Sensors and Transducers
EE-381	Non-Conventional Energy Resources

Course Name: **Engineering Mathematics-III**
Course Code: **MA-203**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To introduce the fundamental concepts relevant to function of complex variable, numerical differentiation and integration and numerical solution of linear, non-linear and system of equations
- To have the idea of evaluation of real integrals using complex variable
- To understand the concept of approximating & interpolating polynomials and finding values of function at arbitrary point
- To impart knowledge of various numerical technique to solve ODE

Unit Number	Course Content	Lectures
UNIT-01	**Functions of Complex Variable** Applications of De Moivre's theorem, Exponential, Circular, Hyperbolic and Logarithmic functions of a complex variable, Inverse Hyperbolic functions, Real and imaginary parts of Circular and Hyperbolic functions, Summation of the series- 'C+iS' method. Limit and derivative of complex functions, Cauchy-Riemann equations, Analytic functions and its applications, Complex integration, Cauchy's theorem, Cauchy's integral formula, Series of complex function, Taylor series, singularities and Laurent's series, Cauchy's residue theorem and its application for the evaluation of real definite integrals.	**12 L**
UNIT-02	**Interpolation** Least square curve fit and trigonometric approximations, Finite differences and difference operators, Newton's interpolation formulae, Gauss forward and backward formulae, Sterling and Bessel's formulae, Lagrange's interpolation.	**6L**
UNIT-03	**Numerical Integration** Integration by trapezoidal and Simpson's rules 1/3 and 3/8 rule, Romberg integration, and Gaussian quadrature rule, Numerical integration of function of two variables.	**5L**
UNIT-04	**Numerical Solution of Ordinary Differential Equations** Taylor series method, Picard's method, Euler's method, Modified Euler's method, Runge- Kutta method. Predictor corrector methods, Adam Bashforth and Milnes method, convergence criteria, Finite difference method.	**7L**
UNIT-05	**Numerical Solution of Linear and Non-Linear Equations** Non-Linear Equations: Bisection Method, Regula Falsi Method, Newton-Raphson Method, Iteration method. Linear Equations: Jacobi and Gauss Seidal Iteration methods, Relaxation method.	**06 L**

Course Outcomes

Upon successful completion of the course, the student will be able to

CO1: Understand and analyze the concept of Numerical Solution of Linear and Non-Linear Equations, Ordinary Differential Equations and Function of complex variable
CO2: Identify an appropriate technique to solve the linear, non-linear equations, ordinary differential equations
CO3: Formulate the problems on related topics and solve analytically
CO4: Apply the concepts of linear, non-linear equations, differential equations and complex analysis in various engineering problems
CO5: Demonstrate the concepts through examples and applications

Books and References

1. Complex variables and Applications by R. V. Churchill, T. J. Brown & R. F. Verhey, McGraw Hill.
2. A first course in complex analysis with applications by Dennis D. Zill & P. D. Shanahan, Jones and Bartlett.
3. Numerical Methods for Scientific and Engineering Computations by M. K. Jain, S. R. K. Iyenger and R. K. Jain, New Age International Publishers, New Delhi.
4. Numerical Methods for Engineers and Scientists by J D Hoffman, CRC Press.
5. Numerical Analysis Mathematics and Scientific computing by D. Kincaid and W. Cheney, American Mathematical Society.

Course Name: **Network Analysis and Synthesis**
Course Code: **EE-211**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the network theorems for AC circuits and transient response of R-L-C for DC and sinusoidal excitation
- To learn the network analysis using graph theory
- To enable the students to understand the significance and practical aspect of network functions and two port network
- To introduce the fundamental concepts of Network realizability and its synthesis

Unit Number	Course Content	Lectures
UNIT-01	**Network theorems and Transient Analysis:** Review of Network theorems for AC circuits: Thevenin's, Norton's, Superposition, Reciprocity theorem, Millman's theorem, compensation, Tellegan's theorem, and Maximum Power Transfer theorems. Transient Analysis of Networks: Network elements, Transient response of R-L-C for DC and sinusoidal excitation, Initial condition, Solution using differential equation approach and Laplace transform method. Self-inductance, Coefficient of coupling, dot convention analysis of coupled circuits, analysis of single tuned and double tuned circuits.	**12 L**
UNIT-02	**Network Graph Theory:** Definition, Graph, Tree, Basic cut- set and tie-set matrices for planer networks-loop and nodal method of analysis of networks with independent and dependent Voltage And current source, Duality And dual networks.	**06 L**
UNIT-03	**Network Functions:** Introduction, driving point and transfer functions, poles and zeros and their significance, network functions for one port and two port networks, time domain behavior from the pole-zero plot.	**06 L**
UNIT-04	**Two-Port Network:** Introduction, different parameters and relationship between different parameters, inter-connections of two port networks, open circuit and short-circuit impedances and ABCD constants, image impedance, image parameters.	**06 L**
UNIT-05	**Network Synthesis:** Network realizability, Hurwitz Polynomials, Positive real functions, Properties of RC, RL And LC networks, Foster and Cauer forms of realization. Introduction to active and passive filters.	**06 L**

Course Outcomes

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

CO1: Identify the suitable theorem for solving a given circuit.
CO2: Describe the importance of DC and AC excitation of a network, and Graph Theory.
CO3: Apply principles of one port and two port networks.
CO4: Assess the Network Synthesis and their realization using Foster and Cauer forms.

Books and References

1. Network and Systems by D. Roy Chowdhury, Wiley Eastern.
2. Network Analysis by Van Valkenburg, Prentice Hall of India Pvt. Ltd.
3. Modern Network Synthesis by M. E. Van Vallkenburg, Wiley Eastern.
4. Fundamental of Electric Circuits by Charles K Alexander and Matthew N. O. Sadiku, TMH Publication.
5. Network Theory and Filter Design by Vasudev K. Aatre, New Age International Publisher.

Course Name: **Electromagnetic Field Theory**
Course Code: **EE-212**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To acquire the basic knowledge of Electromagnetic field theory that allows the student to have a solid theoretical foundation for future applications
- To identify, formulate and solve the electromagnetic fields and waves propagation based problems
- To provide the students with a solid foundation in engineering fundamentals required to solve problems and also to pursue higher studies

Unit Number	Course Content	Lectures
UNIT-01	**Introduction** Review of vector analysis: scalar And vector products: gradient, divergent and curl of a vector and their physical explanation Transformation amongst rectangular, cylindrical and spherical coordinate systems.	**06L**
UNIT-02	**Electrostatics and Magnetostatics** Coulomb's law, electric field intensity from point charges, field due to continuous distribution of charges, Gauss's law, Electric displacement and displacement density potential function, potential field of a point charge, Laplace's and Poison's equations. Magnetic field intensity and magneto motive force, Ampere's Circuital law, Energy stored, Biot Savart law, vector potential, magnetic dipole.	**10L**
UNIT-03	**Time Dependent Fields** Ampere's work law in differential vector form, continuity of currents, conduction and displacement current. Maxwell's equations and their interpretations, boundary conditions. Wave equations, sinusoidal time varying fields, uniform plane wave in dielectric and conductor media, skin effect and depth of penetration, reflection and refraction of plane waves at boundaries for normal and oblique incidence surface impedance.	**10L**
UNIT-04	**Energy Flow and Poynting Vector** Poynting's theorem, interpretation of E x H, simple application, complex poynting vector.	**02L**
UNIT-05	**Guided Waves** Transmission line theory from the circuit concept, properties; constants; transmission line equations; infinite line; reflections in transmission lines; voltage, current and impedance relations-open and short circuit lines; Experimental determination of line constants. Standing wave ratio; impedance matching, quarter and half wave lines, single stub and double stub matching; circle diagram - Smith chart. Waves between parallel planes: Transverse Electric waves, Transverse magnetic waves; characteristics of TE and TM waves; Transverse Electromagnetic waves; velocity of propagation; Attenuation in parallel plane guides; wave impedance**.**	**08L**

Course Outcomes

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

CO1: Apply vector calculus to static and dynamic electromagnetic fields in different engineering situations
CO2: Describe Maxwell's equation in different forms and apply them to diverse engineering problems
CO3: Apply principles of wave propagation in different media and its interfaces and in applications engineering
CO4: Assess the nature of electromagnetic wave propagation in guided medium which are used in transmission of wave

Books and References

1. Electromagnetic waves and Radiating systems by E. Jordan, Prentice-Hall.
2. Principle and applications of Electromagnetic fields by R. Plonsey and R.E. Collin, McGraw-Hill Book Co., New York.
3. Applied Electromagnetics by M.A. Planus, Mc Graw-Hill Book Co.
4. Elements of Electromagnetic by Mathew N.O. Sadiku, Oxford University Press.

Course Name: **Electrical and Electronic Measurements**
Course Code: **EE-213**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To learn the different errors, their sources from where they arise in measurement of a quantity and their analysis
- To explain the basic principle, working and construction of various instruments used for measuring the electrical and magnetic quantities
- To understand various methods for the measurement of different range of resistance
- Learning about various AC bridge methods for the measurement of different range of inductances of a coil and capacitance of a capacitor
- To know the basic principle, working and construction of various instruments used for measuring the power factor and frequency in both single phase and three phase electrical system
- Understanding the basic principle of working of potentiometers, procedures for measurement of electrical quantities using potentiometer and calibration of instruments
- To learn use of instrument transformers for the measurements of high voltage and current in a electrical circuit, various errors which appears in using instrument transformers and methods to reduce

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Measurement Systems:** Static error, Static calibration, Error calibration curve, Limiting errors, Relative limiting errors, Types of errors: Gross Errors, Systematic Errors, Random Errors; Propagation of Errors, Static sensitivity, Linearity, Hysteresis, Threshold, Dead Time, Resolution of instrument, loading effects, Introduction to measurement standards, Expression of uncertainty, Accuracy, and Precision index.	**05L**
UNIT-02	**Electrical and Magnetic Measurements:** Introduction, D'Arsonval galvanometer, moving iron and moving coil instruments, Electrodynamometer, Electrostatic Instruments, Induction type energy-meter, wattmeter. Determination of B-H curve and Hysteresis loop.	**07L**
UNIT-03	**Resistance Measurements:** Methods of measurement of low, medium and high resistance, measurement of earth resistance, localization of cable faults by Murray and Varley loop test.	**05L**
UNIT-04	**Inductance and Capacitance Measurements:** Measurement of inductance and capacitance by A.C. Bridge methods, Q-factor and dissipation factor. Sources of errors in bridge circuits, shielding of bridge elements, Wagner Earthing Device.	**06L**
UNIT-05	**Measurement of Power Factor and Frequency:** Single phase and three phase electrodynamometer type power factor meter. Moving iron power factor meters, types of frequency meter, mechanical resonance type, electrical resonance type, Ratio meter type..	**05L**
UNIT-06	**Potentiometers:** Basic D.C. potentiometer circuit, Modern form of D.C. potentiometer, measurement of voltage, current, Resistance and calibration of voltmeter and ammeter using D.C. potentiometer, volt ratio box, A.C. potentiometers and their applications	**04L**
UNIT-07	**Instrument Transformers:** Introduction, use of instrument transformers, ratios, basic constructional features of C.T. and P.T., ratio and phase angle errors, reduction of errors.	**04L**

Course Outcomes

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

CO1: Understand the basic principle, working and construction of various instruments used for measuring the electrical and magnetic quantities

CO2: Comprehend the merits of various bridge methods used for the measurement of resistance, inductance capacitance

CO3: Understand basic principle of working of potentiometers, its use for measurement of electrical quantities and calibration of instruments

CO4: Realize the requirement of Instrument transformers in high voltage and current measurements

Books and References

1. A Course of Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney and P.Sawhney, Dhanpat Rai & Sons.
2. Electronic Instrumentation and Measurement Techniques by W.D. Cooper and A.D. Helfrick, Prentice-Hall India.
3. Electrical Measurement and Measuring Instruments by E.W. Golding and F.C. Widdis, Wheeler Publishing.

Course Name: **Digital Electronics & Logic Design**
Course Code: **EC-211**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the concept of digital design, number system and codes
- To introduce the fundamental concepts related to design of combinational logic circuits
- To enable the students to understand the design of Sequential Circuits

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Analog versus Digital, Analog to Digital and Digital to Analog converter circuits; Number systems and their inter-conversion, Binary Arithmetic (Addition, Subtraction, Multiplication and Division), Diminished radix and radix compliments; BCD codes, Excess-3code, Gray code, Hamming code, Error Detection and Correction.	**07L**
UNIT-02	**Logic Gates and Logic Families:** Digital Logic Gates, Various Logic Families: RTL, DTL, TTL and ECL; Working and their characteristics; MOS and CMOS devices.	**06L**
UNIT-03	**Combinational Logic Design:**Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Minimization of Logical functions, Karnaugh- Map method, Sum of Products and Product of Sums Simplification, NAND and NOR implementation, Incompletely Specified functions, VEM method, Tabulation method, Determination of Prime implicants, Selection of Essential Prime implicants, Iterative Consensus & Generalized Consensus method for minimization of Multiple Output Switching functions, Determination of Prime implicants, Selection of Essential Prime implicants and finding a minimal cover, Design of Combinational circuits with examples.	**10L**
UNIT-04	**MSI and PLD Components:** Binary Adder and Subtractor; Decoders and Encoders; Multiplexers and DE-Multiplexers circuits; Read Only Memory, Programmable Logic Arrays, Programmable Array Logic; Implementation of Combinatorial Logic using these devices.	**06L**
UNIT-05	**Sequential Logic Design:** Introduction and Classification of Sequential circuits, Flip-flops: Truth Table & Excitation Table of flip-flops, Inter conversion of flip-flops, Design of Synchronous & Asynchronous Sequential circuits, Registers and Counters,	**07L**

Course Outcomes

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

CO1: Understand about the concept of digital system
CO2: Apply principles of minimization techniques to simplify digital functions
CO3: Design and analyse the combinational electronic circuit based on digital logic
CO4: Design and analyse the sequential electronic circuit based on digital logic

Books and References

1. Digital Design: M. Morris Mano, Prentice Hall of India.
2. Digital Principle and Applications: Malvino and Leach, Tata Mc-Graw Hill.
3. Fundamentals of Digital Electronics: Anand Kumar, Prentice Hall of India.
4. Modern Digital Electronic: R.P.Jain Tata Mc-Graw Hill.

Course Name: **Network Analysis and Synthesis Lab**
Course Code: **EE-214**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- Provide hands-on experience to the students so that they are able to put theoretical concepts to practice
- Solve and verify the electrical networks using mesh and nodal analysis
- Solve and verify the electrical networks using network theorems
- To impart knowledge about the experimental determination of two-port network parameters

List of Experiments

1. To verify maximum power transfer theorem.
2. To verify superposition theorem.
3. Determination of peak and average voltage in ac circuits.
4. To check polarity markings of a transformer and to determine self and mutual inductance of windings.
5. To measure inductance of a coil by:
   i. Three voltmeter method.
   ii. Three ammeter method.
   iii. Voltmeter, ammeter and wattmeter method.
6. To find Z, Y, ABCD and H parameters for a two port network.
7. To obtain time constant for a RC circuit when:
   i. RC circuit is switched on with a dc supply.
   ii. Capacitor is discharged through resistance.
8. To charge and discharge a condenser through a resistance using neon bulb.
9. To study characteristics of various active filters.
10. To study RC circuits with varying EMF.
11. To study change over logic in typical offline UPS and its implementation in respect of UPS trainer.
12. To study working of pulse width modulated and Q-sine wave inverter.

Course Outcomes

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

CO1: Apply the fundamentals of circuit theory in solving and verifying various Laws and Theorems
CO2: Express given electrical circuit in terms of A,B,C,D and Z,Y parameter models and solve the circuits
CO3: Be able to determine time constants from RC and RL circuits

Course Name: **Electrical and Electronic Measurements Lab**
Course Code: **EE-215**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- Provide hands-on experience to the students so that they are able to put theoretical concepts into practice
- Solve and measure the basic parameters like resistance, capacitance and inductance using suitable methods
- To impart knowledge about calibrating the voltmeter and ammeter
- To impart knowledge about the experimental determination of quality factor with LCR bridge circuit

List of Experiments

1. To measure unknown resistance using Wheat stone bridge method.
2. To measure insulation resistance of a given wire using megger.
3. To measure unknown capacitance using low voltage Schering bridge.
4. Measurement of unknown inductance and resistance using Maxwell's inductance bridge.
5. To calibrate an energy meter using Phantom loading method.
6. (i) To calibrate the voltmeter using direct reading potentiometer.
   (ii) Measurement of current and resistance using potentiometer method.
7. Measurement of low resistance using Kelvin double bridge method.
8. To determine the value of unknown high resistance using loss of charge method.
9. To measure power and power factor for an inductive circuit using: (i) three voltmeter method (ii) three ammeter method.
10. To calibrate an ammeter using direct reading potentiometer.
11. Measurement of inductance, capacitance, resistance and quality factor (Q) with LCR bridge circuit.

Course Outcomes

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

CO1: Apply the fundamentals of measuring methods in computing basic R,L and C parameters
CO2: To be able to calibrate various instruments like ammeter and voltmeter
CO3: Be able to determine inductance, capacitance and Q factor

Course Name: **Digital Electronics and Logic Design Lab**
Course Code: **EC-214**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- Familiarization with digital integrated circuits and equipments
- Implementation and design of combinational logic circuits using different gates
- To understand concepts of sequential circuits and to analyze and design sequential circuits

List of Experiments

1. To study about the logic gates and verify their truth table.
2. Relization of AND and OR gates using
   (i) Diodes and resistors.
   (ii) Universal gates
3. Design and implement half adder and full adder circuits and verifies the truth table using logic gates.
4. Design and implement half subtractor and full subtractor circuits and verifies the truth table using logic gates.
5. Design and implement 4-bit binary to gray code converter and gray to binary code converter circuits.
6. Design and implement BCD to excess-3 code converter and excess-3 to BCD code converter.
7. Design and implement
   (i) 2-Bit magnitude comparator using basic gates
   (ii) 8-Bit magnitude comparator using IC 7485
8. Design and implement multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154.
9. Design and implementation of the function using multiplexer
   (i) $F(A,B,C)=\Sigma m(1,2,5,6)$
   (ii) $F(A,B,C)=\Sigma m(0,2,5,6,7)$
10. Design and implement encoder and decoder using logic gates and study of IC 7445 and IC 74147.
11. Realization of SR, JK, D and T flip flop using gates.
12. Design and implement 3-bit asynchronous up/down counter.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Understand the digital signals, applications of ICs and logic circuits

CO2: Develop skills for designing combinational logic circuits and their practical implementation on breadboard

CO3: Analyze, design and implement sequential logic circuits

Course Name: **Organizational Behaviour**
Course Code: **HS-203**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the behavioural aspects related to professional organizations
- To introduce the fundamental concepts relevant to understanding of individual & group behavior in the organization
- To enable the students to understand the applied organizational themes like perception, motivation, interpersonal relationships, group dhynamics, leadership theories, role of power & politices in organizational context, conflict and negotiation, organizational diversity, dynamics of personality, attitude and job satisfaction, etc.

Unit Number	Course Content	Lectures
UNIT-01	**Organizational Behavior (OB):** Concept, nature, characteristics, conceptual foundations, determinants and importance, management functions, role & skills, disciplines that contribute to the field of OB, Challenges & Opportunities for OB, diversity in Organizations, attitudes & Job satisfaction.	**04L**
UNIT-02	**Perception**: Concept, nature, process, importance, management and behavioral applications of perception. Personality: concept, nature, types and theories of personality shaping. Learning; concept and theories of learning.	**08L**
UNIT-03	**Motivation:** concept, principles, theories-content, process & contemporary, Monetary and non-monetary motivation, applications of motivation. Leadership: Concept, functions, styles, and theories of leadership- trait, behavioural, and situational.	**06L**
UNIT-04	**Group and Interpersonal Relationship:** Analysis of Interpersonal Relationship, developing interpersonal relationship, Group Dynamic: Definition of Group, stages of Group Development, Punctuated Equilibrium Model, Group Structure, Group Decision Making, understanding work teams.	**05L**
UNIT-05	**Organizational Power and Politics:** concept of power, structure of power, classification of power, contrasting leadership & power, dependence a key to power, causes & consequences of political behaviour. Organizational conflict: view of conflict, conflict process, negotiation & bargaining strategies.	**06L**
UNIT-06	**Conflict and Negotiation:** conflict definition in conflict thought: Traditional view, the Human relation view, interactionist view. Functional versus dysfunctional conflict, conflict process. Negotiation Bargaining strategies, the negotiation process and issues in negotiation.	**07L**

Course Outcomes

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

CO1: Identify the challenges of the present organization

CO2: Describe the organizational system

CO3: Apply the principles of organizational behavior to inculcate the habit of team work and which is essential for the organization

CO4: Assess the role of psychological and social principal in improvement of efficiency as well as quality of empoyee life

Books and References

1. Organizational Behavior by Robbins, S.P., Prentice Hall of India.
2. Organizational Behavior by Luthans F., McGraw-Hill.
3. Human Behavior at Work: Organizational Behavior by Davis K., Tata McGraw-Hill.

Course Name: **Electrical Machines – I**
Course Code: **EE-221**
Course Type: **Core**

Contact Hours/Week: **3L+ 1T** Course Credits: **04**

Course Objectives

- To have knowledge about operation, testing, efficiency and various configurations of single phase & three phase transformers.
- To understand the concepts of rotating electrical machines and principle of energy conversion.
- To impart knowledge about operation, various characteristics, starting and control of DC machines.

Unit Number	Course Content	Lectures
UNIT-01	**Transformers:** Construction, Theory and operation, E.M.F. equation, phasor diagram, rating of transformers, equivalent circuit, open and short circuit tests, back to back test, voltage regulation and efficiency, auto-transformers, three winding transformer, parallel operation of single phase and three phase transformers, three phase transformer connections, phasor groups, three phase to two phase and six phase conversion, Harmonics and excitation phenomenon, inrush current phenomenon.	**10L**
UNIT-02	**Basic Concepts of Rotating Electrical Machines:** Constructional details of various rotating machines, Introduction to Lap and wave windings, EMF generation, Effect of chording and distribution of winding on EMF, Harmonics in generated emf, MMF produced by distributed winding.	**09L**
UNIT-03	**Energy Conversion:** Principle of electromechanical energy conversion, energy stored in a magnetic field system, singly and doubly excited systems.	**07L**
UNIT-04	**DC Machines:** Action of commutator, E.M.F. generated in armature, Torque in DC machines, Methods of excitation, armature reaction, MMF and flux density waveform of DC Machines, Commutation process, interpoles and compensating windings, Basic performance equations of DC machine, Magnetization and operating characteristics of DC generators and DC motors, DC motor starting and speed control, Ward Leonard system, losses and efficiency, applications of DC motors.	**10L**

Course Outcomes

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

CO1: Explain the operation of transformers.
CO2: Carry out various transformer tests and describe harmonics phenomenon.
CO3: Calculate EMF & MMF for various types of windings.
CO4: Explain the theory of electromechanical energy conversion.
CO5: Carry out calculations regarding performance of DC machines.

Books and References

1. Electrical Machinery by P.S. Bhimbra, Khanna Publishers, Delhi.
2. Electrical Machinery Fundamentals by S. J. Chapman, McGraw Hill, New York.
3. Electrical Machines by Ashfaq Hussian, Dhanpat Rai & Company.

Course Name: **Microprocessor Architecture and Interfacing**
Course Code: **EE-222**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives:

- To impart knowledge about microcomputers, microprocessor, associated hardware and its architecture.
- To enable students to write programme in assembly language.
- To enable the students to understand about the interfacing and peripherals used and application of 8085 microprocessor and its applications.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Microprocessors and Microcomputers:** Evolution of microprocessors, Architectural advancements of microprocessors, single-chip microcomputers, large and small computers, microprocessor applications	**03L**
UNIT-02	**Microprocessor Architecture:** Intel 8085, ALU, timing & control unit, registers, opcode & operands, Instruction cycle: fetch operation; execute operation, machine cycle and state, instruction & data flow. Timing diagram: for op-code fetch cycle, memory read, I/O read, memory write & I/O write, Interrupts in 8085, RST instructions, multiple interrupts and priorities.	**09L**
UNIT-03	**Instruction Set and Programming:** Instruction and data formats, Addressing modes, status flags, Classification of instructions: Data transfer group, Arithmetic group, Logical group, Branch, Stack, I/O and Machine control group. Assembly language programs using 8085 instruction set, such as addition, subtraction, shift left, shift right, multiplication, division and involving loops, arrays, subroutines and stacks.	**08L**
UNIT-04	**Memory Interfacing:** Types of memory, ROM & its types, RAM & its types, address decoding, interfacing of memories.	**04L**
UNIT-05	**Peripheral Devices and Interfacing:** Data transfer schemes: synchronous data transfer, asynchronous data transfer, interrupt driven data transfer, DMA transfer,8257 DMA controller, programmable interrupt controller (PIC) Intel 8259, programmable peripheral interface (PPI) Intel 8255, programmable interval timer Intel 8253, programmable communication interface Intel 8251.	**06L**
UNIT-06	**Applications of 8085 Microprocessor**: Introduction, analog to digital Converter (ADC), Interfacing of ADC 0808/0809 and sample and hold to microprocessor 8085, display of decimal numbers and alphanumeric characters, Microprocessor based measurement of Electrical quantities- Frequency, phase angle and power factor, voltage, current. Interfacing of transducers to measure and display the non- electrical quantities such as temperature, water level and speed of motor etc.	**06L**

Course Outcomes

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

CO1: Identify various hardware components of microcomputers and peripherals.
CO2: Describe the various cycles and execution of instructions in CPU.
CO3: Write assembly language program and able to execute the same.
CO4: Assess the performance 8085 microprocessor and its applications.

Books and References

1. Microprocessor Architecture, Programming and Applications with the 8085 by R. S. Gaonkar, Penram International Publishing (India) Pvt Ltd.
2. Introduction to Microprocessors by A. P. Mathur, TMH.
3. Fundamentals of Microprocessors and Microcomputers B. Ram, Dhanpat Rai & Sons.
4. Microprocessor Microcomputer and their Applications by A. K. Mukhopadhyay, Narosa Publishing House.

Course Name: **Power Electronics**
Course Code: **EE-223**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about construction, working principles of key power electronic switches & their switching characteristics.
- To introduce the fundamental concepts relevant to operation of power electronic converters and output waveforms.
- To enable the students understand about various factors which must be considered while designing power electronic systems.

Unit Number	Course Content	Lectures
UNIT-01	**Characteristics of Various Solid State Devices** Semiconductor Power diodes, Power transistors, MOSFET, SCR Thyristor and its two transistor model, Triac, Gate turn off thyristor (GTO), Insulated gate bipolar transistor (IGBT), Comparison of switching power devices, Static Characteristics and Principles of operation, turn on and turn off characteristics, triggering circuits.	**07L**
UNIT-02	**AC to DC Converters** Line commutated thyristor based converters, phase controlled rectifiers, bridge converters - fully controlled, half controlled, uncontrolled (single phase and three phase configuration), bidirectional ac to dc voltage source converters, issues of line current harmonics, power factor, distortion factor and source inductance, Resonant Converters, inverter operation, applications in drives.	**08L**
UNIT-03	**DC to DC Converters** Thyristor choppers, voltage, current and load commutation, step up and step down Choppers, basic principles of DC-DC switch mode Converters, buck, boost and buck-boost converters and applications	**07L**
UNIT-04	**DC to AC Inverters** DC-AC switched mode converters, Voltage source inverters, single phase and three phase inverter, harmonic reduction techniques and Sinusoidal Pulse Width Modulation, current source inverter.	**08L**
UNIT-05	**AC to AC Converters** Single phase and 3-phase AC voltage controllers using thyristors , phase control and integral cycle control, AC choppers, single phase cyclo-converters, applications, effects of harmonics and electromagnetic interference, applications in drives	**06L**

Course Outcomes

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

CO1: Identify role of uncontrolled and controlled power electronic AC and DC Converter systems in developing drive applications.

CO2: Describe contribution of Source Impendence, nature of loads and harmonics on performance of power electronic systems.

CO3: Apply principles of phase control, integral cycle control and resonance for affecting AC and DC circuit performances.

CO4: Assess the role of harmonic mitigation circuits in improving power quality issues amongst power electronic converters.

Books and References

1. Modern Power Electronics by B.K.Bose, IEEE Press, New York.
2. An Introduction to Thyristor and their applications by M.Ramamoorty, East West Press, New Delhi.
3. Power Electronics by P.S.Bhimbra, Khanna Publishers, Delhi.
4. Thyristorised Power Controllers by Dubey, Doradla, Joshi and Sinha, New age International Pub., New Delhi.
5. Power Electronics-Circuits, Devices and Applications by M.H. Rashid, Pearson Education.

Course Name: **Power System**
Course Code: **EE-224**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- Identify major components of power transmission and distribution systems.
- Describe the principle of operation of transmission and distribution equipment.
- Know and appreciate the key factors in equipment specification and network design.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Power System, Load Characteristics and Economic Aspects** Basic structure of power system, sources of electric energy: conventional and non-conventional; cogeneration, combined heat and power, captive power plants, distributed generation. Commonly used terms and factors, curves useful in system operation and planning, economics of power factor improvement, interconnection of power stations and tariffs.	**04L**
UNIT-02	**Transmission Line Parameters** Types of conductors, Ampere's law, inductance of a conductor, inductance of a single phase line, inductance of a three-phase line, inductance of three-phase double circuit line, bundled conductors, skin effect , proximity effect, Guy's theorem, Capacitance of single phase line, capacitance of a three-phase line, capacitance of double circuit three phase line, effect of earth on capacitance.	**08L**
UNIT-03	**Transmission Line Performance** Classification of lines, models, circuit constants of transmission lines: short, medium and long lines; Ferranti effect, power flow through a line, sending and receiving end power circle diagram, reactive power generation/absorption of line, compensation and voltage control.	**08L**
UNIT-04	**Insulators for Overhead Transmission lines and Mechanical Design of Transmission line** Types of insulators, ratings, voltage distribution across suspension insulators, string efficiency, methods to improve string efficiency. Calculation of sag and tension, equivalent span length and sag, effect of ice and wind loading, stringing chart, sag template, conductor vibrations and vibration dampers.	**07L**
UNIT-05	**Corona and Radio interference** Critical voltages, corona loss, advantages and disadvantages of corona, factors affecting corona loss, effect of corona on line design, radio interference.	**02L**
UNIT-06	**Distribution System and Insulated Cables** Effect of voltage on transmission efficiency, Kelvin's law, radial and ring main distributors, interconnectors, methods of feeding distributors, ac distribution, three-phase, four wire distribution system, stepped and tapered mains. Cable conductors, insulating materials, insulation resistance, electrostatic stress in cables, grading of cables, capacitance of a three-core cable, dielectric loss, dielectric power factor, classification of cables, cable performance.	**07L**

Course Outcomes

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

CO1: Comprehend various elements of power system, its changing landscape and different sources of energy.
CO2: Able to produce concepts regarding basics of Electrical Engineering such as KW, KVAR, KVA.
CO3: Able to understand importance of power factor, capacitor bank and metering system in industrial and residential area.
CO4: Able to analyse the Performance of Transmission Lines, Efficiency in Transmission Lines.

Books and References

1. Electric Power systems by C.L. Wadhwa, New Age international, New Delhi.
2. Electric Power generation transmission and distribution by S.N. Singh, Prentice-hall of India, Private Limited, New Delhi.
3. Elements of Power System Analysis by W.B. Stevenson McGraw Hill.
4. Power System Engineering by D.P. Kothari and I.J. Nagrath, Tata McGraw Hill, New Delhi.

Course Name: **Electrical Machines–I Lab**
Course Code: **EE-225**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide basic information about electrical machine parts and their tests.
- To impart knowledge and understanding about of D.C. machine and transformer.
- To acquire basic understanding about the working of dc machines as generators and motors.

List of Experiments

1. To conduct open circuit and short circuit test on a single phase transformer .
2. To conduct a polarity test on a single phase transformer.
3. To study the constructional details and working of transformer.
4. To perform back to back test on a single phase transformer.
5. To perform parallel operation on a single phase transformer for the load sharing between them.
6. To perform load test on a single phase transformer.
7. To study the speed control of a D.C shunt motor by field control method.
8. To study the speed control of a D.C shunt motor by armature control method.
9. To study external load characteristic of D.C shunt generator.
10. To conduct on experiment on a separately excited D.C generator and draw the magnetization characteristic and the determine the critical field resistance and critical path.

Course Outcomes

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

CO1: Student will gain knowledge of various parts of a electrical machine.
CO2: Ability to perform test on D.C. machine to find magnetization characteristic.
CO3: Able to conduct open circuit/ short circuit test on transformer.
CO4: Able to calculate torque and speed of given D.C. Machine.

Course Name**: Power Electronics Lab**
Course Code: **EE-226**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To learn the operation and characteristics of different power semiconductor switches.
- To understand and analyze the operation of controlled rectifier, chopper and cyclo-converter.

List of Experiments

1. To determine the V-I characteristics of silicon controlled rectifier (SCR).
2. To study the output and transfer characteristics of MOSFET.
3. To study output and transfer characteristics of IGBT.
4. To determine the V-I characteristics of DIAC.
5. To determine the V-I characteristics of TRIAC.
6. To observe output waveform across RC load of a chopper which is a voltage commutated SCR.
7. To study the action of voltage commutated chopper and plot output waveform.
8. To study action of single phase half wave rectifier with resistive load.
9. To study operation of single- phase full wave rectifier.
10. To study the operation of single phase to single phase step down cyclo-converter

Course Outcomes

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

CO1: Explain the basic operation of various power semiconductor devices and its applications.
CO2: Analyze power electronic circuits.
CO3: Apply power electronics circuits for different loads.

Course Name: **Microprocessor Architecture and Interfacing Lab**
Course Code: **EE-227**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide ability for drawing flowcharts and writing Assembly Language Programs for a given problem.
- To provide skills to decide machine codes corresponding to Mnemonics and writing/entering machine codes on 8085 microprocessor kit.
- To enable the students to debug the Assembly Language Programs.

List of Experiments

1. (i) Familiarization with 8085 microprocessor kit, hardware and software commands.
   (ii) Detailed description of commands: substitute, move, go to and search.
2. To draw a flowchart and write a well-documented assembly language program (ALP) for addition of two 16-bit hexadecimal numbers. Provision should exist for storing result and carry generated after addition.
3. To draw a flow chart and write a well-documented assembly language program (alp) for subtraction of 16-bit hexadecimal numbers and store the result at some memory location.
4. To draw a flowchart and write an alp for the addition of 'n' number of data bytes stored in memory locations consecutively. Save carry if any generated during addition. Store the entire sum at two consecutive memory locations.
5. To draw flow chart and write an alp for checking a hex number for odd or even parity, if the parity is odd, store 00 at some given memory location and if the parity is even, store ee at that location.
6. To draw a flow chart and write program for multiplication of two 8-bit numbers by repetitive additions (provision for storing 16-bit result).
7. To draw a flow chart and write program for division of 16-bit number with an 8-bit number.
8. To draw a flow chart and write program to arrange the given 'n' numbers stored in a block of memory locations in (i) ascending order (ii) descending order.
9. To write an assembly language program for finding the square of the number by lookup table technique. The values of the number whose squares to be found are given to be between the decimal number 1 to 9.
10. To draw a flow chart and write program to find the largest number of the given numbers stored at consecutive memory locations. Store the largest number at some memory location.
11. To interface relay and opto-isolator with Microprocessor 8085.
12. To interface ADC and DAC with Microprocessor 8085.

Course Outcomes

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

CO1: Identify various electronic components on 8085 microprocessor kit.
CO2: Understand and apply the fundamentals of assembly level programming to solve problems.
CO3: Work with microprocessor interfacing modules including serial ports, digital-to-analog and analog-to-digital converters etc.
CO4: Analyze abstract problems and apply a combination of hardware and software to address the problem.

Course Name: **Protection and Switchgear**
Course Code: **EE-311**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the fault analysis and to understand the impact of fault in a power system.
- To introduce the fundamental concepts relevant to per-unit system their usefulness in fault analysis.
- To understand and implement the protection of transmission lines, transformer and bus bar protection.
- To explain the working principle, applications of circuit breakers.

Unit Number	Course Content	Lectures
UNIT-01	**Per-Unit System and Fault Analysis:** Change of base, per unit quantities in three phase system, selection of base values, base quantities in terms of KV and MVA, per unit load impendence, advantages of per unit representation, one-line diagrams, preparation of impendence and reactance diagrams. Type of faults and their occurrence, symmetrical short circuit on the terminals of an unloaded generator, unsymmetrical faults on the terminals of an unloaded generator, faults on power system and their simulation.	**06L**
UNIT-02	**Introduction to Power System Protection:** Abnormal operating conditions, protective system and its attributes, system transducer, various principles of power system protection.	**04L**
UNIT-03	**Protection of Transmission Lines:** Over current protection through fuse, thermal and over current relay, IDMT relay and application on distribution feeder, directional over current relays, differential and percentage differential protection, distance protection of transmission lines through impedance, reactance and mho relay, comparison between distance relays.	**06L**
UNIT-04	**Transformer and Bus Bar Protection:** Over current protection, percentage differential protection, incipient faults in transformers, inter-turn fault, protection against over fluxing. Differential protection of bus bars.	**05L**
UNIT-05	**Generator Protection:** Various faults and abnormal operating conditions, protection against unbalanced loading, over speeding, loss of excitation, loss of prime mover.	**04L**
UNIT-06	**Advance Protective Systems:** Carrier aided protection of transmission lines, static comparators as relays, synthesis of various distance relays using static comparators, numerical protection.	**05L**
UNIT-07	**Circuit Breaker:** Arc initiation and arc quenching theories, circuit breaker ratings, air circuit breaker, minimum oil circuit breaker, bulk oil circuit breaker, air blast circuit breaker, SF6 circuit breaker and vacuum circuit breaker.	**06L**

Course Outcomes

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

CO1: Understand and implement the per-unit system and utilize it for fault analysis purpose.
CO2: Realize the importance of power system protection and judicious selection of type of protection to be applied.
CO3: Identify the various kinds of faults and competence to implement protection in power system components.
CO4: Understand the various types of circuit breakers according to their application.

Books and References

1. Elements of Power System Analysis by W.D. Stevenson, McGraw Hill.
2. Modern Power System by D.P. Kothari and I.J. Nagrath, Tata McGraw Hill New Delhi.
3. Electrical Power system by Ashfaq Hussain, Vikas Publisher.
4. Power System Analysis by Hadi Saadat, Tata Mc Graw Hill, New Delhi.
5. Switchgear and Protection by Sunil S. Rao, B .Ravindernath & M. Chander, Khanna Publishers, Delhi.

Course Name: **Electrical Machines – II**
Course Code: **EE-312**
Course Type: **Core**

Contact Hours/Week: **3L+ 1T** Course Credits: **04**

Course Objectives

- To learn about operation, characteristics, testing and control of induction machines.
- To have knowledge about operation, starting, characteristics and testing of synchronous machines.
- To impart knowledge about synchronization methods and parallel operation of alternators.

Unit Number	Course Content	Lectures
UNIT-01	**Polyphase Induction Machines:** Theory of three phase induction motors, Principle of operation, slip, phasor diagram, equivalent circuits, expression for torque, maximum torque, starting torque and output power, torque-slip and power-slip characteristics, Circle diagram, Predetermination of characteristics from the circuit diagram, Drawing circle diagram from design parameters and no load and blocked rotor test data, power factor control of three phase induction motor, Starting of Induction motors, Speed control of induction motor, Cogging & Crawling, applications of poly-phase induction motors.	**10L**
UNIT-02	**Single Phase Induction Motors:** Principle of operation on the basis of double revolving field theory, Equivalent circuit, performance calculations and characteristics, Starting methods, Maximum starting torque conditions in single phase induction motors, Hysteresis motor, Reluctance motor and stepper motor.	**09L**
UNIT-03	**Synchronous Machines:** Types of Exciters for synchronous machines, flux and MMF phasor diagrams for cylindrical rotor synchronous machines, Armature reaction, open and short circuit characteristics, Leakage reactances, Synchronous reactance, Phasor diagram under loaded conditions, operating characteristics of alternators and their ratings, Predetermination of regulation by EMF and Potier triangle methods for non-salient pole alternators, Steady state power flow equations, Power angle characteristics, Constant excitation and constant power output, Circle diagram for synchronous machines. Two reaction theory for salient pole alternators and pre-determination for regulation, slip test, V curves, Hunting and its suppression, Starting of synchronous motor, Synchronous condenser.	**10L**
UNIT-04	**Parallel Operation of Alternators:** Synchronization of alternators by dark lamp method, Parallel operation of alternators, Alternator on infinite bus bar, Effect of change of excitation and prime mover inputs.	**07L**

Course Outcomes

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

CO1: Explain characteristics of induction machines from the testing data available.
CO2: Draw and explain circle diagram for induction machines and synchronous machines.
CO3: Carry out calculations for flux, MMF and various parameters of synchronous machines.
CO4: Explain various phenomena associated with synchronous machines.
CO5: Describe and explain various methods of synchronization and conditions for parallel operation of alternators.

Books and References:

1. Electrical Machinery by P.S. Bhimbra, Khanna Publishers, Delhi.
2. Electric Machinery by A.E.Fitzerald, C.Kingsley and S.D.Umans, Tata McGraw Hill.
3. Theory of AC Machinery by A.S.Langsdorf, Tata McGraw Hill.

Course Name: **Signals and Systems**
Course Code: **EE-313**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To develop an understanding of signals, systems and their properties.
- To describe the methods for computing the response of LTI systems.
- To develop an ability to carry out frequency analysis of continuous and discrete- time signals.
- To introduce the concept of linear filtering and explain the importance of frequency domain analysis.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Continuous time and discrete time signals, periodic signals, energy and power signal, transformer of independent variables, even and odd signals, exponential and sinusoidal signal, unit impulse and unit step functions, interconnections of systems, systems with and without memory, causality, stability, linearity and time invariance.	**04L**
UNIT-02	**Sampling:** Introduction, sampling theorem, sampling with zero order hold reconstruction of a signal from its samples, aliasing, sampling of discrete time signals, decimation and interpolation.	**04L**
UNIT-03	**Linear Time Invariant Systems:** Introduction, discrete LTI systems, Convolution continuous time unit impulse response and convolution integral representation of LTI systems, properties of LTI systems, Stability, causal LTI system described by difference equation, singularity functions.	**06L**
UNIT-04	**Fourier Series Representation:** Fourier series representation for continuous time periodic signals, convergence and properties of continuous time Fourier series. Fourier series representation and properties of discrete time periodic signals, Fourier series and LTI system, frequency shaping and frequency selective filters, discrete time filters.	**08L**
UNIT-05	**Continuous and Discrete Time Fourier Transform:** Introduction, representation for a periodic signals, Fourier series representation of a periodic signals, convergence of Fourier transform, Fourier Transform for periodic, properties of continuous time Fourier transform, convolution and multiplication properties systems described by linear constant coefficient different equations. Introduction representation for a periodic signals, DTFT, Fourier transform for periodic signals, convergence of the Fourier transform Gibbs phenomenon, properties of discrete time Fourier transform convolution and mortification properties, system described by linear constant coefficient difference equations.	**08L**
UNIT-06	**Time and Frequency Characterization of Signal and System:** Introduction, magnetic and phase representation of Fourier transform, magnitude and phase representation of frequency response of LTI system, Linear and nonlinear phase, group delay, log magnitude plot, time domain and frequency domain aspects of non-ideal filters 1st and 2nd order continuous time and discrete time systems.	**06L**

Course Outcomes

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

CO1: Demonstrate and explain the properties of signals and systems.
CO2: Find out the response of a LTI system for an arbitrary input.
CO3: Evaluate Fourier series/Transform for a given signal.
CO4: Differentiate between ideal and practical frequency selective filters.

Books and References

1. Signals and Systems by A.V. Oppenheim, A. S. Willsky and Hamid Nawab, PHI Publication
2. Digital Signal Processing by J. G. Proakis and D. G. Manolakis, PHI Publication.
3. Digital Signal Processing: A computer based Approach by Sanjit K Mitra, Tata McGraw Hill.
4. Signals and Systems by Simon Haykin and Barry Van Veen, Wiley Publication.
5. Signal Processing and Linear systems by B. P. Lathi, Oxford University Press.

Course Name: **Transducers and Signal Conditioning**
Course Code: **EE-314**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To identify, formulate and solve the Transducers and signal conditioning based problems.
- To provide the students with a strong foundation in subject fundamentals required to solve industry based problems.
- To acquire the basic knowledge of transducers and signal conditioning for research applications.

Unit Number	Course Content	Lectures
UNIT-01	**Transducers** Introduction, classification, Mechanical devices as primary detectors, Basic requirements of a transducer, Electrical transducers, Type of transducers for measuring displacement, strain, vibration, pressure, Flow, temperature, force, torque, liquid level, Humidity, P. H. value, velocity (angular and linear), acceleration, Basic principles of resistive transducers, Inductive transducers, capacitive transducers, Thermoelectric transducers, Piezoelectric transducers, Hall effect transducers, Electromechanical transducers, Photoelectric transducers, Digital transducers.	**10L**
UNIT-02	**Signal Processing Circuits** Introduction, ideal op-amp, Operational amplifier specifications, Zero crossing detector, Zero crossing detector with Hysteresis, inverting and non-inverting amplifiers, Voltage-follower, adder, subtractor, integrator, Differentiator, voltage to current converter, current to voltage converter, Phase shifter circuit, Absolute-Value circuit, Peak detector, AC to DC converter, logarithmic converter, Differential-amplifier, Instrumentation amplifier, Analog Modulators and demodulators.	**08L**
UNIT-03	**Data Display and Recording Systems** Introduction to Analog and digital display methods, Analog Recorders, C.R.O., digital input-output Devices, Digital frequency meter, Digital Voltmeter.	**07L**
UNIT-04	**Data Transmission and Telemetry** Introduction, Methods of data transmission, General telemetering system, Electrical telemetering systems, Transmission channels and media, Multiplexing in telemetering systems, Characteristics of Frequency division multiplexing, Time-division multiplexing.	**06L**
UNIT-05	**Data Acquisition and Conversion** Introduction, signal conditioning of the inputs, single channel D A S, Multi-channel D A S, Data Conversion, Multi-plexer, S/H circuit, A/D converter.	**05L**

Course Outcomes

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

CO1: Describe working principles of sensors and transducers.

CO2: Understand working principle of transducers used for measurement and comparative study of various transducers.

CO3: The Understanding of different transducers and sensors for applications in industry.

Books and References

1. A course in Electrical, Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons.
2. Transducers and Instrumentation by D.V.S. Murty, Prentice Hall of India Private Limited.
3. Measurement Systems (Application & Design) by Ernest O. Doebelin, McGraw Hill Higher Education, New Delhi.
4. Instrumentation Devices and Systems by C.S. Rangan, G.R. Sharma, and V.S.V. Mani, TMH New Delhi.
5. Operational Amplifiers and Linear Integrated Circuits by Robert F. Coughlin and Frederick F. Driscoll, Prentice-Hall of India.

Course Name: **Power System Protection Lab**
Course Code: **EE-315**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for performing experiments related with power system protection.
- To provide skills for practical applications related with power system protection.
- To enable the students to understand the application of power system protection.

List of Experiments

1. To study the DMT and IDMT characteristics of micro controller based over current relay.
2. To study the DMT and IDMT characteristics of micro controller based over & under voltage relay.
3. To study the characteristics of micro controller based earth fault relay using IDMT and DMT.
4. To study the DMT and IDMT characteristics of micro controller based over frequency relay.
5. To study the DMT and IDMT characteristics of micro controller based under frequency relay.
6. To study the IDMT characteristics of electro mechanical type earth fault relay.
7. To study the characteristics of electro mechanical type over frequency relay.
8. To study the characteristics of electro mechanical type over voltage relay.
9. To study the characteristics of electro mechanical type under voltage relay.
10. To study the characteristics of electro mechanical type over current relay at different current setting.

Course Outcomes

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

CO1: Identify the various practical problems of power system protection.
CO2: To know the practical concepts of power system protection.
CO3: To understand the fundamental practical concepts of various types of relays.

Course Name: **Electrical Machines–II Lab**
Course Code: **EE-316**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide general understanding about electrical machine and their parts.
- To impart knowledge and understanding about of induction and synchronous machine and their tests.
- Acquire knowledge about the starting and speed control of induction motors.

List of Experiments

1. To Obtain Open Circuit and short circuit characteristics of a synchronous generator and calculate its synchronous impedance Zs.
2. To estimate hysteresis and Eddy currents losses of single phase Transformer at rated voltage and frequency by conducting variable frequency at no load test.
3. To Perform load test on 3 phase induction motor.
4. To perform load test on self-excited induction generator.
5. To conduct slip test on the salient pole synchronous machine and calculate X_d and X_q parameters.
6. To perform no load and block rotor test on three phase induction motor and determine the equivalent circuit parameter from these tests.
7. To measure the zero sequence reactance of synchronous machine.
8. To perform starting and the synchronization of three phase synchronous machine by light and dark lamp method.
9. To plot V curves of a synchronous motor.
10. To study the dissectible machine system.
11. To control the speed of 3 phase induction motor using pole changing method.
12. To control the speed of a slip ring induction motor by varying in rotor resistance.

Course Outcomes

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

CO1: Student will gain knowledge of various parts of a electrical machine.
CO2: Ability to conduct experiments on A.C. Machines to find the characteristics.
CO3: Able to calculate torque and speed of given rotating machine.

Course Name: **Transducer and Signal Conditioning Lab**
Course Code: **EE-317**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To understand scientific measurement principles and concepts behind modern electronic instrumentation.
- To understand the principle of various types of transducers.
- To know the construction and working of frequently used equipment's like CRO, Signal generator, etc.

List of Experiments

1. (i) Study of Cathode Ray Oscilloscope, its various controls and their functions.
   (ii) Measurement of AC and DC voltage signals, current, frequency and phase shift using CRO.
2. To study the characteristics of LVDT and measurement of displacement using LVDT.
3. To study piezoelectric transducer and to measure vibration using piezoelectric accelerometer.
4. To study resistive potentiometer transducer and plot its characteristics.
5. Measurement of temperature using: (i) Thermistor (ii) Thermocouple (iii) RTD
6. To study the characteristics of LDR in following modes:
   (i) The lamp voltage is kept constant and the distance between the lamp and LDR is varied.
   (ii)The distance kept constant and voltage is varied.
7. To study airflow sensor.
8. To measure speed of the motor shaft with the help of non-contact pickups:
   (i) Variable reluctance pickup (ii)Photoelectric pickup.
9. (i) To study strain gauge transducer
   (ii)Measurement of forced/load using strain gauge transducer.
10. To study and demonstrate X-T and X-Y recordings using recorder.

Course Outcomes

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

CO1: To identify various errors in measurement system and correct them.

CO2: To know the fundamentals of measuring systems including the particular limitations and capabilities of a number of measuring devices (LVDT, pressure transducers, strain gages, thermocouples, LDR, etc.) and Equipment's (oscilloscope, signal generator, recorders, etc.).

CO3: To be familiar with characteristics of various transducers.

Course Name: **Control Engineering**
Course Code: **EE-321**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives:

- To impart knowledge about developing mathematical models of physical systems and deriving their transfer function.
- To introduce the concept of analyzing the LTI systems for stability in time domain and frequency domain.
- To enable the students to understand the basic control design methods to meet out desired performance/specifications.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Control system:** Historical overview, system, servo-mechanism, open loop and closed loop systems, mathematical modelling of physical systems, mechanical and electrical system analogy.	**03L**
UNIT-02	**Feedback and Non-Feedback Systems:** Block diagram representation and reduction techniques, Signal flow graphs, Mason Gain Formula, feedback and non-feedback systems, regenerative and degenerative feedback, effect of variation of system parameters on system performance, advantages of feedback, Control Components, general block diagram of a control system, a.c. and d.c. Servomotors, a.c. tachometer, synchro transmitter and receiver, synchro pair as control transformer, a.c and d.c position control system, stepper motor etc.	**09L**
UNIT-03	**Time Domain Analysis:** Introduction, standard input signals, Response of 1st and 2nd order systems, time domain specifications i.e. rise time, peak time, delay time, peak overshoot, settling time steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs, Effect of addition of zero to the system.	**06L**
UNIT-04	**Stability Analysis:** Introduction, concept of stability, conditions for stable system, asymptotic, relative and marginal stability, Routh-Hurwitz criterion for stability, Root Locus Technique, concepts of root locus, construction of root loci, and various rules pertaining to locus diagram development	**07L**
UNIT-05	**Frequency Domain Analysis:** Introduction, Relation between time and frequency response for 2nd order system, Bode plot, construction procedure for bode plot, gain cross over and phase cross over frequency, gain margin and phase margin, Nyquist plot & Nyquist stability criterion.	**07L**
UNIT-06	**Control System Design:** Selection and realization of basic compensators like lead, lag and lag-lead compensators etc., Introduction to PID Control.	**04L**

Course Outcomes

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

CO1: Identify different physical systems and classify them as open loop and close loop control systems.
CO2: Describe the mathematical relation between input and output for LTI systems.
CO3: Apply different time domain and frequency domain tools to analyze the absolute and relative stability of LTI systems.
CO4: Assess the performance of LTI systems to different inputs and to design basic controllers to meet out desired performance.

Books and References

1. Control System Engineering by I.J. Nagrath and M. Gopal, Wiley Eastern.
2. Modern Control Engineering by K. Ogata, Prentice Hall India.
3. Control System Engineering by N.S. Nise, Wiley India (P) Limited.
4. Automatic control Systems by B.C. Kuo, Prentice Hall India.
5. Digital control and state variable methods by M. Gopal, Tata McGraw Hill.

Course Name: **Power System Analysis**
Course Code: **EE-322**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the various analysis of power system.
- To introduce the fundamental concepts relevant to power networks, bus impedance algorithms, short circuit, power flow and stability studies.
- To enable the students to understand the factors related with short circuit, power flow and stability studies.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Nature and scope of power system studies, power system restructuring, power system computation and control, Smart grid concept.	**03L**
UNIT-02	**Power system Components modelling:** Mathematical model of transmission lines, tap changing transformer, generator and loads.	**04L**
UNIT-03	**Topological Analysis of Power Networks:** Primitive impedance and admittance matrices, system graph for transmission network, relevant concepts in graph theory, network representation, network matrices, network reduction.	**06L**
UNIT-04	**Bus Impedance Algorithm:** Partial network, addition of link(s), addition of branch(es), removal of elements, implementation of bus building algorithm, 3-phase Z-bus formation.	**06L**
UNIT-05	**Short Circuit Studies:** Types of faults, short circuit studies of large power system networks, calculating system conditions after the occurrence of fault, direct short circuit i.e. bolted faults. Comparison between symmetrical components and phase coordinate, method of short-circuit studies.	**06L**
UNIT-06	**Power Flow Studies:** Mathematical model of power flow studies, Solution techniques: Gauss-Seidel method, Newton-Raphson method, fast decoupled load flow method, comparison of solution technique.	**06L**
UNIT-07	**Stability Studies:** Types of stability, swing equation, point by point method, mathematical models for transient stability simulation, equal area criteria, direct numerical integration method.	**05L**

Course Outcomes

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

CO1: Identify different power system analysis problems.
CO2: Describe problems related with power networks, bus impedance algorithms, short circuit, power flow and stability studies.
CO3: Apply principles to solve problems described in CO2.
CO4: Assess the results obtain by solving above problems.

Books and References

1. Computer Techniques in Power System Analysis by M.A. Pai, Tata McGraw Hill, New Delhi.
2. Advanced Power System Analysis and Dynamics by L.P. Singh, New Age International
3. Modern Power System Analysis by DP Kothari and I.J. Nagrath, Tata McGraw Hill, New Delhi.

Course Name: **Digital Signal Processing**
Course Code: **EE-323**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To provide an overview of applications of DSP and explain its advantages over ASP.
- To develop an ability to compute DFT and understand efficient methods for computing it.
- To explain the methods for designing FIR and IIR filters.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Basic elements of digital signal processing, comparison of analog and digital signal processing, multi-channel and multi-dimensional signals, random and deterministic signals, FIR and IIR systems, recursive and non-recursive systems, correlation of discrete time signals.	**04L**
UNIT-02	**Discrete Fourier Transform and Fast Fourier Transform:** Frequency domain sampling and reconstruction of discrete time signals, DFT, DFT as linear transformation, frequency analysis of signals using DFT, properties of DFT, circular convolution, linear filtering methods based on DFT, overlap save and overlap add method, FFT algorithms, decimation in time and decimation in frequency algorithms, applications of FFT algorithms, linear filtering approach to computation of the DFT, Goertzel algorithm.	**10L**
UNIT-03	**Implementation of Discrete Time Systems:** Structures for the realization of LTI systems, recursive and non-recursive realization of FIR systems, structures for FIR systems, direct form, cascade form, frequency sampling and lattice structures, structures for IIR systems, direct form, signal flow graphs and transposed structure, cascade, parallel form and lattice structures.	**08L**
UNIT-04	**Design of FIR Digital Filters:** Introduction, LTI systems as frequency selective filters, Paley-Wiener theorem, characteristics of frequency selective filters, design of linear phase FIR filters, design of digital filters by placement of poles and zeros in z-plane, digital resonators, Notch filters, Comb filters and all pass filters, design of linear phase FIR filters using windows and by frequency sampling method.	**08L**
UNIT-05	**Design of IIR Digital Filters:** Introduction, design of IIR filters from their analog counterparts, design using approximation of derivatives, impulse invariance, bilinear transformation and matched z-transformation, frequency transformations in analog and digital domains, design of digital filters based on least squares method, design of IIR filters in frequency domain.	**06L**

Course Outcomes

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

CO1: Apply analytical methods for solving systems described by difference equations.
CO2: Understand and explain the effiecient methods for computing Fourier transform.
CO3: Realize FIR/IIR systems using efficient structures.
CO4: Design simple FIR and IIR filters for given specifications.

Books and References

1. Digital Signal Processing by J.G. Proakis and D.G. Manolakis, Pearson Education Publisher.
2. Digital Signal Processing by A.V. Oppenheim and R.W. Schafer, Prentice Hall Publisher.
3. Digital Signal and Image Processing by Tamal Bose, John Wiley and Sons Publisher.
4. Digital Signal Processing by Sanjit K. Mitra, Tata McGraw Hill Publisher.
5. A Course in Digital Signal Processing by Boaz Porat.

Course Name: **Electric Drives**
Course Code: **EE-324**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart basic knowledge on electrical drive.
- To introduce the fundamental concepts relevant to ac and dc motor drives.
- To enable the students to understand the factors that causes the selection of a drive for particular application.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Electric drive system-Introduction, advantages, parts, classification, requirements and choice criteria, Dynamic equations of an electric drive, torque equations, multi-quadrant operation, types of loads, energy loss during transients and load equalization.	**06L**
UNIT-02	**Selection of Motor Drive Rating:** Selection of motor rating – thermal model of motor, classes of duty and determination of motor rating for different classes of drive operation duty.	**06L**
UNIT-03	**DC Motor Drives:** Starting, braking, speed control using single-phase and three-phase half and fully controlled rectifiers, chopper fed DC drives.	**08L**
UNIT-04	**Induction Motor Drives:** Starting and braking methods, speed control of SCIM using ac voltage controllers, VSI and CSI, v/f control, speed control of wound-rotor IM using rotor-resistance variation, slip-power recovery scheme and cyclo converter fed induction motor drives.	**10L**
UNIT-05	**Synchronous Motor Drives:** VSI drive, brushless excitation, true synchronous and self-controlled operation, PMSM and BLDC motor drives, synchronous reluctance motor	**06L**

Course Outcomes

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

CO1: Identify suitable electric motor drive for particular application.
CO2: Describe the operation of dc motor drives to satisfy four-quadrant operation.
CO3: Explain the working of various phase controlled converters used in AC Drives.
CO4: Understand on the operation, working, and controlling of VSI based drives.

Books and References

1. Electric Motor Drives by R. Krishnan, PHI.
2. Electric Drive by M. Chilikin, Medtech.
3. Power Semiconductor Controlled Drives by G. K. Dubey, Prentice Hall.
4. Power Semiconductor Drives by S. B. Dewan, G. R. Slemon, and A. Straughen, John Wiley.

Course Name: **Control Engineering Lab**
Course Code: **EE-325**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To analyze transient and steady state behavior of a control system experimentally.
- To study different control components and their utility as error detectors.
- To learn and implement basic control mechanisms using compensators and PID controllers.

List of Experiments

1. To study potentiometer based error detector and to draw its characteristics.
2. To study speed control and reversal of stepper motor using microprocessor.
3. To study synchro transmitter – receiver pair and its operation as an error detector.
4. Study of two phase AC servo motor and draw its speed torque characteristics.
5. To study voltage sensitive bridge and to analyze its sensitivity and linearity.
6. To study D.C. position control system and to execute position control through continuous and step command.
7. To design, implement and study the effects of different cascade compensation networks for a given system.
8. To study the Digital control system and to implement digital PID control for a modeled process.
9. To study relay as nonlinear element and effect of dead-zone and hysteresis on the controlled process.
10. To study speed control of DC Servomotor using PID controller.
11. To study magnetic amplifier and to plot control current versus load current characteristics for series, parallel and self-saturation mode configuration.
12. To study and perform simple two step open loop control and proportional control on process control simulator kit.

Course Outcomes

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

CO1: Understand and evaluate the steady state and transient performance of LTI systems.
CO2: Design and develop simple control mechanisms for given LTI systems.
CO3: Understand the characteristic behavior of AC/DC actuators and their industrial applications.

Course Name: **Power System Analysis Lab**
Course Code: **EE-326**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- Provide hands-on experience to the students so that they are able to put theoretical concepts to practice.
- To impart knowledge about the experimental determination of transmission line parameters.
- To familiarize the students with the methods/ techniques for analyzing breakdown voltage.

List of Experiments

1. To obtain the ABCD parameters of transmission line model.
2. To measure the breakdown voltage of transformer oil.
3. Determination of power angle characteristics of transmission line.
4. To improve the voltage profile at a load bus using a shunt capacitor.
5. To verify the Ferranti effect in transmission line.
6. To determine the breakdown voltage of solid insulator.
7. To draw the PV characteristics of a transmission Line.
8. To draw the characteristics of a series compensated transmission line.
9. To determine the earth resistance using megger.
10. To study and compare the performance of a 230V, 500m long ring mains and radial distribution systems.

Course Outcomes

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

CO1: Apply the fundamentals of power system in solving and verifying Ferranti effect.
CO2: Be able to understand the concept of breakdown in insulators.
CO3: Be able to determine transmission line A, B, C, D parameters.

Course Name: **Engineering Economics and Accountancy**
Course Code: **HS-404**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Economics and its applicability to the Engineers
- To introduce the fundamental concepts of economics
- To enable the students to understand the factors that causes the changes in economic conditions of the entrepreneur

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Engineering Economics:** Definitions, Nature, Scope and application; Difference between Micro Economics and Macro Economics; Theory of Demand & Supply: Meaning, Determinants, Law of Demand, Elasticity of demand, Demand Forecasting, Law of Supply, Equilibrium between Demand & Supply.	**06L**
UNIT-02	**Production and Cost**: Production functions, Isoquant, Least Cost combination, Laws of Returns to Scale. Economics and Diseconomies of Scale of production, Cost and Cost curves, Revenue and Revenue curve, Break even analysis.	**06L**
UNIT-03	**Costing and Appraisal:** Cost elements, Economic cost, Accounting cost, Standard cost, Actual cost, Overhead cost, Cost control, Criteria of project appraisal, Social cost benefit analysis	**05L**
UNIT-04	**Markets**: Meaning, Types of Markets, Characteristics (Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly) Price and Output Determination; Product Differentiation; Selling Costs; Excess Capacity.	**05L**
UNIT-05	**Money**: Meaning, Functions, Types; Monetary Policy- Meaning, Objectives, Tools; Fiscal Policy:-Meaning, Objectives, Tools. **Banking:** Meaning, Types, Functions, Central Bank: its Functions, concepts CRR, Bank Rate, Repo Rate, Reverse Repo Rate, SLR.	**04L**
UNIT-06	**Depeciation:** Meaning of depreciation, causes, object of providing depreciation, factors affecting depreciation, Methods of Depreciation: Straight line method, Diminishing balance method, Annuity method and Sinking Fund method	**04L**
UNIT-07	**Financial Accounting:** Double entry system (concept only), Rules of Double entry system, Journal(Sub-division of Journal) , Ledger, Trial Balance Preparation of final accounts-Trading Account. Profit and Loss account, Balance Sheet.	**06L**

Course Outcomes

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

CO5: Identify the challenges of the economy as entrepreneur/manufacturer as well as consumer
CO6: Describe the economic system at the micro and macro level
CO7: Apply principles of economics and accountancy in the professional, personal and societal life
CO4: Assess the role of engineering economics and accounting in attaining economic efficiency

Books and References

1. Principles of Micro Economics by Mceachern & Kaur, Cengage Publication.
2. Managerial Economics by Craig Peterson & W Cris Lewis, PHI Publication.
3. Modern Microeconomics by A. Koutsoyiannis, Macmillan.
4. Managerial Economics Theory and Applications by D. M.Mithani. Himalaya Publication House.
5. Fundamental of Managerial Economics Mark Hirschey, South Western Educational Publishing.
6. Engineering Economics by Degramo, Prentice Hall.
7. Financial Accounting–A Managerial Perspective by R. Narayanaswamy, PHI.
8. Introduction to Accounting by J.R. Edwards & Marriot, Sage Publication.
9. Cost Accounting by Jawahar Lal, Tata McGraw Hill.
10. Project Planning Analysis, Selection, Implementation and Review by Prasanna Chandra, Tata McGraw Hill

Course Name: **Modern Control Systems**
Course Code: **EE-411**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about developing state space models from differential/transfer function based descriptions of linear systems.
- To introduce difference equation description of discrete time LTI systems and analyzing their stability.
- To introduce the typical behaviors shown by nonlinear systems and to analyze the stability of such systems.
- To introduce the preliminary understanding about the advanced control methodologies used to handle systems with uncertainty.

Unit Number	Course Content	Lectures
UNIT-01	**State Variable Analysis and Design:** Introduction, concept of state, state variable and state model, state space representation of systems, block diagram for state equation, Transfer function decomposition, direct, parallel and cascade decomposition, solution of state equations, concept of controllability and observe ability, controller design using pole placement by state feedback, controller design using state observer.	**10L**
UNIT-02	**Sampled Data Control:** Introduction, digital control systems, quantization concept, data acquisition, conversion and distribution system, z-transform, Important properties, inverse z-transform, difference equation and solution using z-transform, Impulse sampling and data hold, reconstruction of original signals from the sampled version.	**06L**
UNIT-03	**Analysis of Discrete Time Systems :** Pulse transfer function for open loop and closed loop systems, mapping between z-plane and s-plane, stability analysis using Jury's test, bilinear transformation and Schur-Cohn criteria, state space representation of discrete time systems and solution of discrete time state equations.	**07L**
UNIT-04	**Nonlinear Systems:** Introduction, different non-linearities, phase plane method, singular points, stability of nonlinear systems, construction of phase trajectories, phase plane method, concepts of describing function method, stability analysis using describing function method, jump resonance phenomena, Liapunov and Popov stability criterion.	**10L**
UNIT-05	**Advanced Control Systems**: Introduction to Uncertain systems, robust and H-infinity control, Model Reference Adaptive Control.	**03L**

Course Outcomes

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

CO1: Develop different state space representations for linear time invariant systems.
CO2: Write descriptions for discrete time systems and analyse the stability of such systems.
CO3: Understand and justify the peculier behaviours shown by nonlinear systems.
CO4: Analyse the stability of nonlinear systems using phase plane, describing function and Lyapunov method.

Books and References

1. Discrete time Control Systems by K. Ogata, Prentice Hall International.
2. Control System Engineering by I.J. Nagrath and M. Gopal, Wiley Eastern.
3. Digital Control Systems by B.C. Kuo, Oxford University Press.
4. Digital control and state variable methods by M. Gopal, Tata McGraw Hill.
5. Applied Nonlinear Control by J.J.E. Slotine & W. Li, Prentice Hall, Englewood Cliffs, New Jersey.

Course Name: **High voltage Engineering**
Course Code: **EE-421**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the physical high voltage phenomena's and their impact in HV systems.
- To introduce the fundamental concepts relevant to high voltage insulations and their characterization.
- To enable the students understand about various factors that must be considered while design and safer use of high voltage systems.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Levels of voltages, Electrical Insulation and Dielectrics, Importance of Electric Field Intensity in the Dielectrics, Types of Electric Fields, Degree of Uniformity of Fields (Schwinger Factor), Stress Control.	**03L**
UNIT-02	**Gaseous Dielectrics** Properties of atmospheric air and SF6, Related ionization Process, Properties of vacuum, Related ionization Process, Development of Electron Avalanche, Breakdown Mechanisms, Townsend's Mechanism, Streamer Mechanism, Breakdown in Uniform Fields (Paschen's Law), Breakdown of gaseous dielectrics in Weakly Non-uniform and the limiting value of η, Development of 'Partial Breakdown' (PB) in Extremely Non-Uniform Fields, Breakdown characteristics' in air with stable PB (corona)	**10L**
UNIT-03	**Liquid and Solid Dielectrics** Classification and Properties of Liquid Dielectrics, Classification and Properties of Solid Dielectrics, Permittivity and Polarization in Dielectrics, Insulation Resistance, Conductivity and Losses in Dielectrics, Partial Breakdown Phenomenon in Dielectrics, Partial Breakdown Phenomenon on the Surfaces of Solid and Liquid Dielectrics, Breakdown in Liquid and Solid Dielectrics Measurement of Intrinsic Breakdown in solid dielectrics, Thermal and other Breakdown Mechanisms in extremely non-uniform fields, Comparison of the development of breakdown in extremely and weakly non-uniform fields and the requirement of time for breakdown in solid dielectrics.	**06L**
UNIT-04	**Generation of High Test Voltages & Measurement techniques** Methods of generation of Power Frequency high test voltage, Transformers in Cascade, Resonance Transformers, Generation of high dc voltage, Voltage Multiplier Circuits and Ripple Minimization, Sources of over voltages and Standard Lightning and Switching wave shapes, Impulse Voltage Generator, Analysis of Single Stage Circuit, Multistage Impulse Generator and their Triggering Methods., Measurement of High Test Voltages i.e. Peak High Voltage measurement techniques, Sphere gap; Effects of earthed objects and atmospheric conditions, Electrostatic Voltmeters, Principle and Construction, Potential Dividers, their types and applications	**12L**
UNIT-05	**Non-destructive High Voltage Testing and Quality Control** Measurable properties of dielectrics, Measurement of Dielectric properties with Schering Bridge and Mega-ohm meter, Partial Breakdown (PB) Measurement Techniques in Dielectrics/ Equipment.	**03L**
UNIT-06	**Insulation Coordination and Over Voltages in Power Systems** Over voltages and Basic insulation level design.	**02L**

Course Outcomes

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

CO1: Identify role of high voltage insulations and their impact in implementing design of HV systems.
CO2: Describe contribution of partial discharges and arcing which if ignored can lead to failure of HV system.
CO3: Apply principles of generation, measurements of all kind of high voltage waveforms in type tests of HV equipment.
CO4: Assess the role of insulation co-ordination and other performance parameters affecting safer application of High Voltages.

Books and References

1. High Voltage Engineering by M.S. Naidu and V. Kamaraju, Tata McGraw Hill.
2. High Voltage Engine Engineering by E. Kuffel and M. Alldullah, Pergamon Press, Oxford.
3. High Voltage Engineering by E. Kuffel and Zaengal, Butterworth-Heinemann.

Course Name: **Communication Systems**
Course Code: **EE-422**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the fundamental concepts of communication systems.
- To understand the basic concept of analog modulation schemes using continuous wave and pulse train as carrier signal.
- To study the working of the practical receiver used in broadcasting applications.
- To learn the sampling process and different schemes for digital modulation.
- To introduce the fundamental concepts of advanced communication systems.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Communications Systems:** Communication process, sources of information, communication channels, base band and pass band signals, representation of signals and systems, switched communication systems.	**05L**
UNIT-02	**Continuous-wave Modulation:** Amplitude modulation (AM), frequency spectrum of the AM wave, representation of AM, power relations in the AM wave, AM detector, vestigial side-band modulation.	**06L**
UNIT-03	**Angle Modulation:** Frequency spectrum of Frequency Modulation (FM) and Phase Modulation, generation of FM (direct and indirect method), demodulation of FM signal.	**06L**
UNIT-04	**Radio Receiver:** Tuned Radio-Frequency (TRF) receiver, super heterodyne receiver.	**03L**
UNIT-05	**Pulse Modulation:** Sampling process, Pulse Amplitude Modulation (PAM), Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM).	**06L**
UNIT-06	**Digital Modulation Techniques:** Quantization process, Pulse Code Modulation (PCM), Differential Pulse Code Modulation (DPCM), Delta Modulation (DM), Adaptive Delta Modulation, Amplitude –Shift Keying (ASK), Frequency-Shift Keying (FSK), Phase-Shift Keying (PSK).	**06 L**
UNIT-07	**Advanced Communication Systems:** Computer communication system, satellite communications, mobile communication.	**04L**

Course Outcomes

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

CO1: Understand the basic communication systems, various sources of information, and communication channels.
CO2: Describe various analog modulation scheme and their relative merits and demerits.
CO3: Understand the basis for digital modulation scheme and its advantages over analog modulation scheme.
CO4: Realize the basic concept of advanced communication systems.

Books and References

1. Communication Systems by Simon Haykin, John Wiley & Sons Pvt. Ltd.
2. An Introduction to Analog and Digital Communications by Simon Haykin, Wiley India Pvt. Ltd.
3. Principles of Communication Systems by H. Taub and D.L. Schilling, McGraw-Hill Education
4. Electronic Communication Systems by George Kennedy, McGraw-Hill Education
5. Principles of Communication Engineering by Anokh Singh, S. Chand & Co.

Course Name: **Neural Networks and Fuzzy Logic**
Course Code: **EE-430**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To acquire the basic knowledge of neural network and fuzzy logic for future applications.
- To impart knowledge about the application of artificial intelligence techniques in engineering.
- To identify, formulate and solve the neural network and fuzzy logic based problems.
- To provide the students with a strong foundation of subject to pursue higher studies and research.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction** Biological foundation, mathematical model of biological neuron, types of activation function, feed-forward and feedback ANN models.	**05L**
UNIT-02	**Learning Paradigms** Supervised and unsupervised learning, learning rules, single layer and multilayer perceptron model, error back propagation learning algorithm, pattern classification, clustering, Kohonen self-organizing feature map, radial basis function network, support vector machines, Hopfield network, Associative memory and BAM, applications of ANN models to engineering problems**.**	**12L**
UNIT-03	**Fuzzy Sets and Theory** Crisp sets, fuzzy sets, fuzzy set operations, properties, membership functions, measures of fuzziness, fuzzification and defuzzification methods, fuzzy relations, operation on fuzzy relations, fuzzy numbers and arithmetic, fuzzy implications, approximate reasoning, systems based on fuzzy rules, fuzzy inference.	**10L**
UNIT-04	**Fuzzy Control Systems** Introduction, fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems.	**04L**
UNIT-05	**Hybrid Intelligent Systems** Genetic algorithms, neuro-fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems.	**05L**

Course Outcomes

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

CO1: Describe working of different intelligent system.
CO2: Able to apply these techniques in different field, which involve perception, reasoning and learning.
CO3: Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
CO4: Assess the results obtained by ANN and fuzzy systems.

Books and References

1. Introduction to Artificial Neural Systems by Jacek M Zurada,West Publisher.
2. Neural Computing: Theory and Practice by Philip D. Wasserman,Van Nostrand Reinhold.
3. Neural Networks -Algorithms, Applications, and Programming Techniques by Freeman, J. A. and D. M.Skapura, Pearson Education.
4. Essentials of Fuzzy Modeling and Control by Ronald R. Yager and Dimitar P. Filev, John Wiley & Sons Inc.
5. Neural Networks, Fuzzy logic and Genetic Algorithm: Synthesis and Applications by S. Rajasekaran and G. A. Vijayalakshmi Pai, PHI New Delhi.

Course Name: **Optimization Methods in Engineering**
Course Code: **EE-431**
Course Type: **Professional Elective-1**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the principles of optimization techniques.
- To introduce the fundamental concepts relevant to classical optimization methods, linear programming, nonlinear programming and dynamic programming.
- To enable the students to understand the factors that causes the different optimization methods to provide different solutions for the same mathematical problem.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Historical Development; Engineering applications of Optimization; Art of Modeling; Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems based on nature of constraints, structure of the problem, deterministic nature of variables, separability of functions and number of objective functions.	**04L**
UNIT-02	**Linear Programming:** Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems; simplex method with artificial variables	**08L**
UNIT-03	**Optimization using Calculus:** Stationary points - maxima, minima and saddle points; Functions of single and two variables; Global Optimum; Convexity and concavity of functions of one and two variables; Optimization of function of one variable and multiple variables; Gradient vectors; Examples; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to inequality constraints; Hessian matrix formulation; Eigen values; Kuhn-Tucker Conditions; Examples.	**07L**
UNIT-05	**Nonlinear programming:** One dimensional minimization methods, elimination, sequential and descent methods, unconstrained optimization techniques, Direct search methods, Descent methods, 2nd order methods, quasi-newton method, Constrained optimization, Indirect methods, exterior penalty function, interior penalty function, geometric view point, augmented Lagrange multiplier.	**12L**
UNIT-06	**Dynamic Programming:** Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP); Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP, application example	**05L**

Course Outcomes

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

CO1: Identify different types of optimization techniques and problems.
CO2: Describe techniques like calculus based classical optimization, linear programming, nonlinear programming, dynamic Programming.
CO3: Apply principles and techniques described in CO2 to solve sample mathematical and practical optimization problems.
CO4: Assess the results obtained by applying optimization techniques to solve mathematical programming problems.

Books and References

1. Introduction to optimization by Pablo Pedregal, Publisher, Springer.
2. Numerical optimization with applications by Suresh Chandera, Jaydeva, and Aparna Mehta Publisher, Narosa.
3. An Introduction to optimization by Edvin K.P. Chong, and Stanislaw H. Zak Publisher, John Wiley.
4. Engineering optimization Theory and ractice by Singiresu S. Rao, New Age International Publisher.

Course Name: **Probability, Random Variables and Stochastic Processes**
Course Code: **EE-432**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the elementary concepts of axiomatic probability. The importance of conditional probability and its use in computing the probability of unknown events.
- To impart knowledge about the random variable and build the confidence for handling uncertainties along with the ideas of probability distribution/density functions and other moments will help the student to understand the real time data and their characterization.
- Extending the random variable concept to two or more random variables and introducing the concept of their statistical properties.
- Highlight the importance of the characteristic function which makes the analysis of the random variables simple and the concept of limit theorems to help in simulation study for communication or filtering problems.
- Introducing the real life signals which are stochastic signal, their characterization is essential while dealing with any application. To provide an understanding how analysis of the stochastic signals can be made in the time domain and frequency domain.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Probability Theory:** Meaning of probability, definitions, set theory, probability space, conditional probability, probability of repeated trials and combined experiments, asymptotic theorems.	**07L**
UNIT-02	**Concept of Random Variable, and functions of one Random Variable:** Introduction, distribution, and density functions, conditional distributions, and total probability. Functions of one random variable and their distribution, and density functions, Mean, Variance, Moments, and characteristic functions.	**11L**
UNIT-03	**Two Random Variables and their functions:** Joint (bi-variate) distributions, one function of two random variables, two function of two random variables, joint moments of two random variables, joint characteristic functions, conditional distributions and mean square estimation	**09L**
UNIT-04	**Sequences of Random Variables and their functions:** General concepts, characteristic functions, mean square estimation, stochastic convergence and limit theorems, random number meaning and generation.	**05 L**
UNIT-05	**Stochastic Processes:** Definitions, system with stochastic inputs, power spectrum, mean square estimation; prediction, filtering	**04L**

Course Outcomes

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

CO1: Understanding of basic concept of probability theory.
CO2: Modeling the real situation/uncertainties using concept of probability.
CO3: Understanding the random variables and processes.
CO4: Statistical methods for analyzing the random processes.

Books and References

1. Probability, Random Variables and Stochastic Processes by Papoulis, TMH Publication.
2. Modern Probability Theory and its Applications by E. Parzen, Wiley Publication.
3. An Introduction to Probability Theory and its Applications by W. Feller, Wiley, Publication.
4. Probability and Statistics with Reliability and Queuing and Computer Science Applications by K. S. Trivedi, PHI Learning.

Course Name: **Process Modeling and Control**
Course Code: **EE-433**
Course Type: **Professional Elective-I**

Contact Hours/Week:**3L** Course Credits:**03**

Course Objectives

- To impart knowledge about the process dynamics/Mathematical modeling and their control schemes generally used to get optimized output.
- To introduce the fundamental concepts of classical and adaptive controller design in various loops.
- It also makes students aware of decoupling of control loops, real-time systems and distributed Computing in industrial process.

Unit Number	Course Content	Lectures
UNIT-01	**General Concepts**: Review of general concepts, terminology, applications of process control. Simulation and Modeling: Importance of simulation, Mathematical modeling, Process dynamics of fluid flow and heat transfer systems, Mass transfer dynamics and distillation column, Reaction kinetics of chemical processes.	**09L**
UNIT-02	**Advanced Control Schemes:** Structure, analysis and application of Cascade control, Selective control, Ratio Control, Design of steady state and dynamic Feed forward controller, Feed forward combined with feedback control, Structure, analysis and applications of inferential control, dead time and inverse response compensators, Concepts and applications of Adaptive control, Model reference adaptive control, Self tuning regulator.	**12L**
UNIT-03	**Design of Multi-loop Controllers:** Interactions and decoupling of control loops. Design of cross controllers and selection of loops using Relative Gain Array (RGA).	**07L**
UNIT-04	**Real Time Control:** Characteristics and classes of real-time systems, program classification: sequential, multi-tasking, real time, concurrency and synchronization, design strategies. Distributed Computing Systems: Distributed processing issues in distributed data base systems.	**08L**

Course Outcomes

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

CO1: The students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables.

CO2: The students will be able to handle different types of classical controller like PID as well as adaptive controllers such as Model reference adaptive control and Self tuning regulator.

CO3: The students will be able to implement different control schemes to various processes.

CO4: The students will be able to real time and distributed computing systems.

Books and References

1. Process Systems Analysis and Control by Donald R. Coughanowr, Tata McGraw-Hill.
2. Design of Feedback Control System by Raymond T. Stefani, Oxford University Press.
3. Modern Control System Theory by M. Gopal, New Age International (P) Ltd, New Delhi.

Course Name: **Design of Feedback Control Systems**
Course Code: **EE-450**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the control system and its analysis on all practical systems.
- To introduce the fundamental concepts relevant to Controllers.
- Highlight the importance of state space design of systems.
- To explain the parameters to be taken into consideration while designing a compensator.

Unit Number	Course Content	Lectures
UNIT-01	**Control System and Analysis:** Differential equations, Lap lace Transforms, Transfer functions of linear systems, Transient response characteristics and system stability, Disturbance and Sensitivity, Transient performance and effects of zeros	**08L**
UNIT-02	**Frequency Domain Design:** System Bode plot, Open loop and closed-loop behavior in frequency domain, Frequency response analysis, Gain and Phase Margins.	**07L**
UNIT-03	**Classical Control Design Techniques:** Introduction to system design using compensators, Root locus rules, Root locus compensation design, Lead, Lag, Lead-Lag compensation,	**07L**
UNIT-04	**Controllers and Compensation techniques:** PI, PD and PID controllers, Feedback compensation, Feed forward control.	**06L**
UNIT-05	**State Space Design of Systems:** Introduction to state space formulation, Concepts of controllability and observability, Full state feedback control design, Observer design, Integrated full state feedback and observer design.	**08L**

Course Outcomes

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

CO1: Apply the fundamentals of control system analysis to understand the design of various controllers.
CO2: Contribute as well as bring about innovations and developments in some areas like control design methods.
CO3: Realize the requirement of pre-requisite measures required to carry out state space design of the system.
CO4: Identify the type of controllers.

Books and References

1. Discrete time Control Systems by K. Ogata, Prentice Hall International.
2. Control System Engineering by Nagrath and Gopal, New Age International.
3. Digital Control Systems by B.C. Kuo, Oxford University Press.

Course Name: **Advanced Microprocessor Systems and Microcontrollers**
Course Code: **EE-451**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about various terms such as Multiprogramming, Multi-user System, Batch processing, Multi-tasking, Machine, Assembly and High-level language, Modular, structured programming, Microprogramming.
- To introduce the basic concepts relevant to 8086 μP architecture and its operating modes.
- To enable the students to understand 8086 ALP using assembler directives and 8086 instruction set.
- To enable the students to understand NDP 8087 and its interfacing to μP 8086.
- Awareness about 8051 microcontroller, memory organization in Intel 8051/8031, various addressing modes and instruction set. To apply the concepts to achieve a dedicated embedded controller as a component of a larger system.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Evolution of Microprocessors and Microcontrollers, Multiprogramming, Multi-user System, Batch processing, Multi-tasking, Multiprocessor, Machine language, Assembly language, High-level language, Modular programming, structured programming, Microprogramming.	**02L**
UNIT-02	**8086 Microprocessor:** CPU architecture, PIN diagram and signal description for 8086, operating modes of 8086, Minimum mode 8086 based system, Maximum mode 8086 based system, instruction format, addressing modes of 8086, Intel 80x86 Family of Processors: Intel 80186,Intel 80286, Intel 80386, Intel 80486,Pentium microprocessor, Advanced Pentium microprocessor.	**06L**
UNIT-03	**Instruction Set and Programming:** Instruction set of 8086, memory and I/O interfacing, interrupts, Assembler directives, 8086 assembly language programming using loop instructions, jump instructions, programming using conditional and unconditional jumps, compare, rotate, addition, subtraction, multiplication and division instructions etc.	**08L**
UNIT-04	**NDP 8087 Interfacing:** Numeric Data Processor 8087, architecture and interfacing of NDP 8087 to microprocessor 8086, Trends and developments in Numeric Data Processors.	**04L**
UNIT-05	**Microcontrollers:** Introduction, functional block diagram of Intel 8051/8031 microcontroller, Memory organization in Intel 8051/8031 microcontroller, Memory and I/O interfacing in Intel 8051/8031 based system, Examples of memory and I/O interface in 8031/8051 based system, Addressing modes.	**06L**
UNIT-06	**Instruction set of Intel 8051/8031:**Instruction set of Intel 8051/8031,Assembly language programming, Assembler Directives, Peripheral devices and interfacing, parallel data transfer schemes, Serial data communication in 8051 microcontroller, DAC interface, ADC interface, Application examples of Intel 8051 microcontroller, Intel 8096 microcontroller, architecture and SFRs of 8096, Trends and developments in microcontrollers.	**10L**

Course Outcomes

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

CO1: Understand the architecture and working of Intel 8086 microprocessor.

CO2: Understand assembly language programming using 8086 instructions and interfacing of NDP 8087 with 8086 microprocessor.

CO3: Comprehend the architecture Intel 8051 microcontroller, assembly language programming using 8051 instruction set.

CO4: Design and develop small practical systems using microcontrollers.

Books and References

1. Microprocessor and Interfacing (Programming and Hardware) by Douglas V. Hall, TMH India.
2. Microprocessors and Microcontrollers by A. Nagoor Kani, RBA Publications.
3. Microcomputer systems the 8086/8088 family by Yu-cheng Liu and Glenn A. Gibson, PHI.
4. 8051 Microcontroller by K.J. Ayala, PHI, New Delhi.

Course Name: **Optimal Control Theory**
Course Code: **EE-452**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To develop basic understanding about various optimal control problems on the basis of performance measures.
- To enable the students to formulate optimal control problems for continuous systems with and without constraints.
- To introduce the calculus of variation based approach to address continuous-time and discrete-time optimization problems.
- To impart basic knowledge about time, fuel and energy optimal control problems with constraints.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Optimal control problem, classification of optimal control problems, performance measures for optimal control problems, selection of performance measures.	**03L**
UNIT-02	**Static Optimization:** Static optimization problem formulation, direct method, Lagrange multiplier method, optimization without constraints, optimization with equality constraints.	**04L**
UNIT-03	**Calculus of Variation:** Fundamental concepts, Euler-Lagrange equation for different two point boundary value problems with free or fixed final condition, Dynamic optimization with equality and non-equality constraints, Pontryagin minimum principle, optimization using gradient method and steepest descent method.	**12L**
UNIT-04	**Linear Quadratic Regulator Problem:** Problem formulation for continuous time systems and discrete time systems with quadratic performance index, open loop and closed loop implementation, Matrix-Riccati equation, output regulator and tracking problem.	**09L**
UNIT-05	**Multistage Optimization Process:** Introduction to multistage decision process, principle of optimality, Dynamic Programming based optimization, Hamilton-Jacobi-Bellman principle.	**04L**
UNIT-06	**Constrained Optimal Control Problems:** Introduction, Time optimal control of LTI systems, block diagram description, Fuel optimal control problem, Energy optimal control problem.	**04L**

Course Outcomes

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

CO1: Identify and formulate different optimal control problems on the basis of Performance Index.
CO2: Develop analytical solutions for optimal control problems with and without constraints.
CO3: Analyse the class of optimal control problems with quadratic objective function in continuos and discrete setting.
CO4: Develop optimal control framework to address constrained problems involving time, fuel and energy minimization.

Books and References

1. Modern Control System Theory by M Gopal, Wiley Eastern, New Delhi.
2. Optimal Control Systems by D .S. Naidu, New CRC Press, USA.
3. Optimum Systems Control by A.P. Sage & C.C White, Englewood Cliff New Jersey, Prentice Hall.
4. Optimal Control Theory by D.E Kirk, Englewood Cliff New Jersey, Prentice Hall.

Course Name: **Power Quality and Harmonics**
Course Code: **EE-453**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the power system and power quality.
- To introduce the fundamental concepts relevant to harmonics and grounding.
- To enable the students to understand the factors that cause the power quality and harmonics problems in the distribution system.
- To enable the students to understand the overall concept and the changing power definitions under non sinusoidal power system environment.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Introduction to power quality, voltage quality. Overview of power quality, Power quality phenomena and classification of power quality issues.	**04L**
UNIT-02	**Power Quality Measures and Standards:** THDTIF-DIN-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, EMC standards and recommended practices.	**06L**
UNIT-03	**Harmonic Device Modelling:** Harmonics background, basic concepts, Fourier analysis. Harmonics-individual and total harmonic distortion-RMS value of harmonic waveform-triplex harmonic-important harmonic introducing devices-Transformer, Three phase power converters-arcing devices-saturable devices. Harmonic distortion due to fluorescent lamps. Effect of power system harmonics on power system equipment and loads.	**08L**
UNIT-04	**Modelling of Networks:** Modelling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and impact on drives.	**08L**
UNIT-05	**Harmonic Mitigation:** Harmonic resonance, Impedance Scan Analysis- Passive filtering. Introduction to active power filtering. Control methods for single phase APFC.	**06L**
UNIT-06	**Grounding:** Grounding and wiring –introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.	**04L**

Course Outcomes

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

CO1: Identify and understand the power quality concepts.
CO2: To characterize various types of power quality problems.
CO3: Apply principles of harmonic mitigation to bring down the level of harmonics within the standard limits.
CO4: Assess the impact of power quality and harmonics in an industrial distribution system.

Books and References

1. Understanding Power Quality Problems by Math H. Bollen, John Wiley IEEE Press.
2. Power System Quality Assessment by J. Arrillaga, John Wiley.
3. Power System Harmonic Analysis by J. Arrillaga, B. C. Smith, N. R. Watson & A. R. Wood, John Wiley.
4. Electrical Power System Quality bySurya Santoso, H. Wayne Beaty, Roger C. Dugan, and Mark F. McGranaghan, McGraw Hills.
5. Electric Power Quality by G. T. Heydt, Stars in a Circle Publishers.
6. Research papers of reputed authors taken from IEEE, IET, Elsevier Science and other std. Journals and magazines.

Course Name: **Power System Operation and Control**
Course Code: **EE-440**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the power system operation and control.
- To introduce the fundamental concepts relevant to economic dispatch, load frequency control, neutral grounding.
- To enable the students to understand the factors that cause the generation of surge voltages on transmission lines.

Unit Number	Course Content	Lectures
UNIT-01	**Power System Control Centres:** Aim of control centre, planning objective, functions of control centres, central facilities, communication, telemetry, emergency control.	**02L**
UNIT-02	**Economic Dispatch:** Characteristics of power generation unit; cost curves, incremental cost curve, heat rate curve, incremental efficiency, constraints in economic operation of power system, optimal allocation of total load among different units, derivation of kron's loss formula, optimal allocation of total load when transmission losses are considered.	**06L**
UNIT-03	**Load Frequency Control:** Types of alternator exciters, exciter modeling, modeling of alternator, static performance of AVR loop, dynamic performance of AVR loop, compensation in AVR loop, automatic load frequency control, types of turbine representation, steady state performance of the speed governing system, complete structure of primary ALFC loop and its responses, secondary ALFC loop and its performance, extension of ALFC loop to multi-area system, tie-line power flow model, static and transient responses of two area system, application aspects of primary and secondary ALFC loop, interfacing of AGC with economic dispatch	**12L**
UNIT-04	**Grounding System:** Resistance of grounding system, design principles of substation grounding system, neutral grounding, ungrounded system, resonant, solid, resistance, reactance, earthing, transformer grounding, neutral grounding practice.	**04L**
UNIT-05	**HVDC Transmission:** Limitation of AC transmission system, advantages and disadvantages of HVDC transmission, type of HVDC links, main components of HVDC transmission	**04L**
UNIT-06	**Travelling Waves:** Propagation of surges, energy and power of a surge, velocity of travelling waves, reflection and refraction of waves, line connected to cable, reflection and refraction at a T-junction, junction of several lines, attention and distortion of travelling waves. Brewley Lattice diagram(BLD), repeated reflections, example BLD calculations.	**08L**

Course Outcomes

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

CO1: Identify different types of power system operation and control problems.
CO2: Describe HVDC transmission, grounding methods, coronas loss formula.
CO3: Apply principles of travelling waves to determine and draw Brewley Lattice diagram.
CO4: Assess the application aspects of primary and secondary ALFC loop, interfacing of AGC with economic dispatch.

Books and References

1. Power System Analysis by Hadi Saadat Tata McGraw Hill, New Delhi.
2. Power System Analysis Operation and Control by Abhijit Chakrabarti and Sunita Halder, PHI New Delhi
3. Electrical Power Systems by Ashfaq Hussain, CBS publication.
4. Power System Operation & Control by K. Uma Rao, Wiley India Pvt. Ltd.

Course Name: **Reactive Power Control and FACT Devices**
Course Code: **EE-441**
Course Type: **Professional Elective-III**

Contact Hours/Week: 3L **Course Credits: 03**

Course Objectives

- To introduce the various topologies of the power electronics circuits.
- To provide basic understanding of the emerging power electronics technologies for power utility applications.
- To enable students to understand the harmonics issues in power utility and means of controlling it using power electronics.
- To enable students to design power electronics circuit that can control active and reactive power flow.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Fundamentals of ac power transmission, transmission problems and need emergence of FACTS-FACTS control considerations, FACTS controllers.	**05L**
UNIT-02	**Principles of Shunt Compensation:** Variable Impedance type and switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.	**08L**
UNIT-03	**Design Principles of Static Series Compensation:** Series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).	**09L**
UNIT-04	**Principles of Operation:** Steady state model and characteristics of a static voltage regulators and phase shifters- power circuit configurations.	**08L**
UNIT-05	**UPFC:** Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.	**06L**

Course Outcomes

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

CO1: Describe the technical characteristics and performance of the electric power system with and without power electronics support.
CO2: Identify, formulate and analyse complex problems in electric power engineering.
CO3: Identify different power electronic based solutions for improving both the steady state and the transient.
CO4: Communicate and work effectively on why and how power electronics can be used for power utility applications.

Books and References

1. Flexible ac transmission systems (FACTS) by Y. H. Song, and T. Allan, Institution of Electrical Engineers Press, London.
2. Concepts and Technology of flexible ac transmission system by Hingorani and L.Gyugyi, IEEE Press New York.
3. IEE Tutorials on 'Flexible ac transmission systems' published in Power Engineering Journal, IEE Press.

Course Name: **Deregulation of Power System**
Course Code: **EE-442**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the restructuring and deregulation of power sector.
- To introduce the fundamental concepts relevant to transmission pricing, models of deregulation, ancillary services and international experience of deregulation.
- To enable the students to understand the basic concepts of deregulation.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, congestion management components of deregulated system, advantages of competitive system.	**07L**
UNIT-02	**Transmission Pricing:** Marginal pricing of Electricity, nodal pricing, zonal pricing, embedded cost, postage stamp method, contract path method, boundary flow method, MW mile method, MVA-mile method, Comparison of different methods.	**10L**
UNIT-03	**Deregulation of Power Sector:** Separation of ownership and operation deregulated methods, pool model, pool and bilateral trades model, multilateral trade model, ancillary services.	**10L**
UNIT-04	**Deregulation Scenario:** England and Wales, Norway, China, California, New Zealand and Indian Power System.	**09L**

Course Outcomes

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

CO1: Identify different problems related with deregulation of power industry.
CO2: Describe problems related with transmission pricing, deregulation models, ancillary services and international experience.
CO3: Apply principles to solve problems described in CO2.
CO4: Assess the results obtained by solving above problems.

Books and References

1. Power system Restructuring and Deregulation edited by Loi Lei Lai, John Wiley & Sons Ltd.
2. Understand Electric Utilities and Deregulation by Lorrin Philipson and H Lee Willis, CRC PRESS.
3. Restructured Electrical Power System Operation, Trading and Volatility by M. Shahidehpour & M.Alomoush, Marcel Dekker Inc.
4. Power System Restructuring Engineering and Economics by M. Ilic, F. Galiana and L. Fink, Kluwer Academic Publisher, USA.

Course Name: **Design of Hydro Power Station**
Course Code: **EE-443**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the planning involved in setting up of a hydro power plant and to understand the impact of hydro units in a global and societal context.
- To introduce the fundamental concepts relevant to hydro power plants.
- Highlight the importance of stability of hydro power plants.
- To explain the parameters to be taken into consideration while designing a hydro power plant.

Unit Number	Course Content	Lectures
UNIT-01	**Layout and Planning of Hydro Power Plant:** Introduction, layout of power house, types of hydro power schemes, stages of investigation, PFR, DPR, hydrology, water availability and water conductor system. Penstocks, types, penstock supports, trash racks	**07L**
UNIT-02	**Power Potential Estimation of Hydro Power Plants:** Head, dependability analysis, layout of electrical equipment in hydro power station, selection of number of units, capacity of power plant and energy generation, and economics of the hydro power plant.	**06L**
UNIT-03	**Turbines:** Introduction, types of hydraulic turbines and their suitability for power plant, governing of turbines, electro hydraulic governors, time constants of governors and their importance, hydraulic turbine losses and efficiency, cavitation, silt erosion.	**08L**
UNIT-04	**Hydro Generators:** Introduction, construction and types of hydro generators, specifications of hydro generators, characteristics of hydro generators, general arrangement of water wheel generators: large horizontal shaft generators, vertical and reversible generators, low speed generators, umbrella type, brakes and jacks, losses and efficiency of hydro generators, parallel operation of alternator in a hydro power plant. Insulation and temperature limits, testing of generators, generator cooling and ventilation, fire protection, design of auxiliary and grounding systems, switchyard equipments, transformers and circuit breakers.	**11L**
UNIT-05	**Stability of Hydro Power Plants:** Special features of hydro power plant stability.	**04 L**

Course Outcomes

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

CO1: Apply the fundamentals of hydrology, to various hydraulic and civil structures as required for hydro-power projects.

CO2: Contribute as well as bring about innovations and developments in some areas like wave power and new technologies in hydraulic structures.

CO3: Realize the requirement of pre-requisite measures required to maintain the stability in a hydro power plant.

CO4: Design hydro power plant particularly, electrical design part.

Books and References

1. Hydro Electric Engineering: Vol.I,II,III, by J. Guthrie Brown, Blackie & Son Ltd., London.
2. A Hand Book of Hydro Electric Engineering by N.C. Nigam, Nem Chand Publishers, Roorkee.
3. Generation of Electrical Energy by B.R. Gupta, S. Chand & Co.
4. Elements of Electrical Power Station, Design by M.V.Deshpande, AH Wheeler & Co. Ltd.
5. Electrical Machines, by D.P. Kothari and I.J. Nagrath, TMH.

Course Name: **Transformer Engineering**
Course Code: **EE-460**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the transformer engineering.
- To introduce the fundamental concepts relevant to maintenance, winding and insulation, cooling, magnetic circuits and tap changer of transformer.
- To enable the students to understand the concepts of transformer.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Transformers:** Transformer Types, Transformer Losses, Operating Principles, Instrument Transformers, Transformer Construction, Auto -Transformer, Transformer connections.	**06L**
UNIT-02	**Transformer Maintenance:** Insulation Testing, High Potential Testing, Turns Ratio Testing, Polarity Testing, Power Factor, Excitation Current, DC Winding Resistance, Polarization Recovery, Insulating Fluid, Dielectric, Dissolved Gas Analysis.	**07L**
UNIT-03	**Materials for Transformers, Winding and Insulation:** Insulating oil, insulating paper, pressboard, and wood, insulated copper conductor for windings, crepe paper, sealing materials, and cold – rolled grain oriented electrical steel sheet. Types of windings, surge voltage, heat transfer, insulation design.	**07L**
UNIT-04	**Cooling of Transformers:** air cooled oil-immersed, water-cooled, forced-oil cooling, self-cooling with air blast temperature limits, transformer loading.	**06L**
UNIT-05	**Magnetic Circuit:** Materials, design of magnetic circuit, optimum design of core.	**05L**
UNIT-06	**Tap Changers and Transformer Auxiliaries:** Off - circuit tap changer, on load tap changer, automatic control of tap changer. Buchholz relay, temperature indicators, oil level indicators, oil preservation systems.	**05L**

Course Outcomes

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

CO1: Identify different problems related with the transformer engineering.
CO2: Describe problems related with winding, insulation, cooling, magnetic circuits and tap changer of transformer.
CO3: Apply principles to solve problems described in CO2.
CO4: Assess the results obtain by solving above problems.

Books and References

1. Transformers by BHEL, Bhopal, Tata McGraw Hill.
2. Transformer Engineering design and practices, S.V. Kulkarni and S.A. Khaparde, Marcel Dekker Inc. New York.
3. Electrical Machines by Husain Ashfaq , Dhanpat Rai & Sons.
4. Electric Machinery by A.E. Fitzgerald, C.Kingsley Jr and Alexander Kusko, McGraw Hill.

Course Name: **Advanced Electrical Machines**
Course Code: **EE-461**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart basic knowledge on advanced electrical machines.
- To introduce the fundamental concepts relevant to permanent magnet motor drives.
- To enable the students to understand the selection of suitable drive for particular application.

Unit Number	Course Content	Lectures
UNIT-01	**Stepper Motors:** Constructional features-Principle of operation-Modes of excitations-Theory of torque predictions, Types motor- Variable reluctance motor , Single and multi-stack configurations Hybrid motor, Disc Magnet motor, Claw tooth motor Linear and non-linear analysis-Static and Dynamic Characteristics, Drive Circuits Microprocessor based control of stepper motors, Closed loop control Applications of stepper motors	**06L**
UNIT-02	**Switched Reluctance Motors:** Construction; principle of operation; torque production, modes of operation, Steady state performance, Power converter circuits- Control of SRM Rotor position sensors-Hall effect sensing scheme, Optical position sensing scheme, Current Regulators-Voltage PWM type, Hysteresis type, Sensor-less operation	**08L**
UNIT-03	**Permanent Magnet Synchronous Machines:** Types of permanent magnets and their magnetization characteristics, demagnetizing effect, Principle of operation, Ideal PMSM, EMF and Torque equations, Armature reaction MMF, Synchronous Reactance Sine wave motor with practical windings , Control of PMSM, Power Converter-Volt-ampere requirements-Torque speed characteristics, Linear Synchronous Motors	**08L**
UNIT-04	**PM Brushless DC Motors:** Permanent Magnet materials-Magnetic Characteristics – Permeance coefficient Magnetic circuit analysis, Electronic commutation- Principle of operation –Types of motor, Theory of brushless DC Motor as variable speed synchronous motor, EMF and torque equations, Commutation Power controllers, Motor characteristics and control, Closed loop control	**08L**
UNIT-05	**Servomotors:** DC Servomotors, AC servomotors, Two-phase AC servomotor, Three-phase AC servomotors and modern trends.	**06L**

Course Outcomes

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

CO1: Understand constructional and operational aspects, characteristic of stepper motors and PM motors.
CO2: Identify suitable PM motor drive for particular application.
CO3: Describe the operation of servo motor drives.
CO4: Explain the working of SRM drive and its control.

Books and References

1. Electric Motor Drives by R. Krishnan, PHI.
2. Stepping Motors and Their Microprocessor Controls by T. Kenjo, Clarendon Press, Oxford.
3. Switched Reluctance Motor Drivesby R. Krishnan, CRC Press.
4. Permanent Magnet Synchronous and Brushless DC Motor Drives, R. Krishnan, CRC Press.
5. Design of Brushless Permanent Magnet Machines, J.R. Hendershot and T.J.E. Miller, Motor Design Books LLC.

Course Name: **Advanced Power Electronics**
Course Code: **EE-462**
Course Type: **Professional Elective- IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about various kind of advanced power electronic converters.
- To introduce the fundamental concepts relevant to harmonic analysis of input and output waveforms of advanced converters.
- To highlight the importance of power line conditioners and their impact in real time applications.
- To enumerate applications of advanced converters in performance control of electrical drives.

Unit Number	Course Content	Lectures
UNIT-01	**AC to DC Converters** Harmonic analysis of output voltage and input current for 2-pulse and 6 pulse controlled rectifiers and methods of reducing these harmonics, Multi-pulse rectifiers**.**	**07L**
UNIT-02	**DC to AC Converters** Analysis of output voltage waveforms of single phase and three phase voltage source inverters. Methods of reducing output harmonics.	**09L**
UNIT-03	**Resonant Converters** Classification, basic resonant converter, loads resonant converter, resonant switch converter and zero voltage switching, emerging trends in this field**..**	**08L**
UNIT-04	**Power Conditioners and UPS** Power line disturbances, generation of harmonics, harmonic standards and recommended practice, power conditioners and uninterruptible power supplies, EMI & EMC related issues, mitigation methods, recent trends.	**06L**
UNIT-05	**Motor Drive Applications** Converters for adjustable speed DC motor and induction motor drives. Methods of improving voltage, current profile of an electric drive, latest trends in the drive performance control.	**06L**

Course Outcomes

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

CO1: Identify and predict the impact of harmonics in a power electronic circuit fed by modern power electronic converters.

CO2: Formulate and solve power electronics circuit equations dealing with harmincs in AC and DC power electronic converters.

CO3: Realize the requirement of power line conditioners in electric power control applications.

CO4: Identify the type of power electronic converters needed for electric drive performance control applications.

Books and References

1. Power Electronics by Nedmohan, Undeland and Robbins, John Wiley India Publishers.
2. Thyristorised Power Controllers by G.K. Dubey, Wiley Eastern.
3. Modern Power electronics & Drives by B.K. Bose, Prentice Hall, PJR.
4. Power Electronics by P.S. Bhimbra, Khanna Publishers, Delhi.
5. Control of Electrical Drives by Werner Leonard, Springer, International Publication.

Course Name: **Electrical Machine Design**
Course Code: **EE-463**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the design principles of electrical machines.
- To introduce the fundamental concepts relevant to the Design of Distribution and Power transformers.
- To enable the students to understand Complete Design Procedure of Single and Three phase Induction Motors.
- To enable the students to understand Complete Design Procedure of Single and Three phase Induction Motors.
- To enable the students to understand Design Procedure of Three phase Synchronous Cylindrical and Salient type of Alternator.
- To make the students aware about the use of computers in the electrical machines design.

Unit Number	Course Content	Lectures
UNIT-01	**Principles of Design of Machines:** Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC.	**05L**
UNIT-02	**Heating, Cooling and Ventilation:** Heating and cooling of machines, types of ventilation, continuous and intermittent rating.	**05L**
UNIT-03	**Design of Transformer:** General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, calculation of losses, efficiency and regulation, forces winding during short circuit.	**10L**
UNIT-04	**Three Phase Induction Motors:** General considerations, output equation, choice of specific electric and magnetic loadings, efficiency, power factor, number of slots in stator and rotor, elimination of harmonic torques, Design of stator and rotor winding, slot leakage flux, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, efficiency from design data.	**10L**
UNIT-05	**Alternators:** Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions.	**04L**
UNIT-06	Introduction to Computer Aided Electrical Machine Design.	**02L**

Course Outcomes

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

CO1: Understand the basic design principles of design limitations and latest design trends of AC machines design.
CO2: Apply design concepts to design the winding, core, frame and cooling circuit of single phase and three phase transformers.
CO3: Analyze the performance and accomplish complete design of single phase and three phase induction motors.
CO4: Design the main dimensions, selection of stator and rotor slots, insulation, type of windings of a three phase alternators.

Books and References

1. A Course in Electrical Machine Design by A. K. Sawhney, Dhanpat Rai & Sons.
2. Principles of Electrical Machine Design with Computer Programs by S.K. Sen, Oxford and IBH.
3. Design of Transformers by Inderjit Das Gupta, Tata Mcgraw Hill.
4. Electric Machinery by A.E Fitzerald, Charles Kingsley, Tata Mcgraw Hill.

Course Name: **Neural Networks and Fuzzy Logic Systems**
Course Code: **EE-370**
Course Type: **Open Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To gain the introduction of Neural networks and fuzzy logic systems for future applications.
- To impart knowledge about the application of artificial intelligence techniques in different field of engineering.
- To identify, formulate and solve the neural network and fuzzy logic based problems.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction** Biological foundation, mathematical model of biological neuron, feed-forward and feedback ANN models, types of activation function.	**05L**
UNIT-02	**Learning Paradigms of ANN** Supervised and unsupervised learning, learning rules, single layer and multilayer perceptron model, error back propagation learning algorithm, pattern classification, clustering, Kohonen self-organizing feature map, radial basis function network, Hopfield network, applications of ANN models to engineering problems**.**	**11L**
UNIT-03	**Fuzzy Sets and Theory** Crisp sets, fuzzy sets, fuzzy set operations, properties, membership functions, measures of fuzziness, fuzzification and defuzzification methods, fuzzy relations, operation on fuzzy relations, fuzzy numbers and arithmetic, fuzzy implications, approximate reasoning, systems based on fuzzy rules, fuzzy inference.	**10L**
UNIT-04	**Fuzzy Control Systems** Introduction, fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems.	**05L**
UNIT-05	**Hybrid Intelligent Systems** Genetic algorithms, neuro-fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems.	**05L**

Course Outcomes

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

CO1: Describe working of artificial neural network and fuzzy logic systems.
CO2: Able to apply these techniques in different field, which involve perception, reasoning and learning.
CO3: Analyze and design a real world problem for implementation and understand the dynamic behavior of a system and assess the results obtained by ANN and fuzzy systems .

Books and References

1. Introduction to Artificial Neural Systems by Jacek M Zurada,West Publisher.
2. Neural Networks-Algorithms, Applications, and Programming Techniques by J.A. Freeman, & D. M. Skapura, Pearson Education.
3. Essentials of Fuzzy Modeling and Control by Ronald R. Yager and Dimitar P. Filev, John Wiley & Sons Inc.
4. Fuzzy System Theory and its applications by T. Terano K Asai and M. Sugeno, Academic Press.
5. Neural Networks, Fuzzy logic and genetic Algorithm: Synthesis and Applications by Rajasekaran S. and Pai G. A. Vijaylakshmi Pal, PHI New Delhi.

Course Name: **Elements of Control System**
Course Code: **EE-371**
Course Type: **Open Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about developing mathematical models of physical systems and deriving their transfer function.
- To introduce the concept of stability in time domain and frequency domain for linear time invariant systems.
- To introduce the concept of state variables and system analysis using state space analysis.

Unit Number	Course Content	Lectures
UNIT-01	**Basic Concepts:** Historical review, Definitions, Classification, Relative merits and demerits of open and closed loop systems.	**01L**
UNIT-02	**Mathematical Models of Control System:** Linear and non-linear systems, Transfer function, Mathematical modelling of electrical, mechanical and thermal systems, Analogies, Block diagrams and signal flow graphs.	**07L**
UNIT-03	**Control Components:** DC servomotor, AC servomotor, Potentiometers, Synchros, Stepper-motor, Sensors and transducers.	**03L**
UNIT-04	**Time and Frequency Domain Analysis:** Transient and frequency response of first and second order systems, Correlation ship between time and frequency domain specifications, Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control.	**08L**
UNIT-05	**Stability Analysis:** Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.	**09L**
UNIT-06	**State Variable Analysis:** Introduction, Concept of State, State variables and State models, State Space representation of linear continuous time systems. State models for linear continuous –time systems and linear discrete time systems, Solution of state equations, Concept of Controllability and Observability, control systems design using state feedback control.	**08L**

Course Outcomes

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

CO1: Identify different physical systems and classify them as open loop and close loop control systems.
CO2: Describe the mathematical relation between input and output for LTI systems.
CO3: Apply different time domain and frequency domain tools to analyse the absolute and relative stability of LTI systems.
CO4: Apply the concept of state space analysis for the analysis of linear time invariant systems.

Books and References

1. Discrete time Control Systems by K. Ogata, Prentice Hall International.
2. Control System Engineering by I. J. Nagrath and M. Gopal, New Age International.
3. Digital Control Systems by B.C. Kuo, Oxford University Press.
4. An Introduction to Control Systems by Warwick and Kevin, World Scientific Publishing Co. Pvt. Ltd.
5. Control System Fundamentals by W. S. Levine, CRC Press.

Course Name: **Sensors and Transducers**
Course Code: **EE-380**
Course Type: **Open Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To makes students familiar with the constructions and working principle of different types of transducers.
- To knows the methods of measurement, classification of transducers and to analyze error.
- To understand the behavior of transducers under static and dynamic conditions.

Unit Number	Course Content	Lectures
UNIT-01	**Science of Measurements and Classification of Sensors and Transducers:** Units and standards, Static calibration, Classification of errors, Limiting error and probable error, Error analysis, Statistical methods, Odds and uncertainty, Classification and selection of sensors and transducers.	**06L**
UNIT-02	**Characteristics of Transducers**: Static characteristics: Accuracy, precision, resolution, sensitivity, linearity, span and range. Dynamic characteristics: Mathematical model of transducer, Zero, I and II order transducers, Response to impulse, step, ramp and sinusoidal inputs.	**06L**
UNIT-03	**Variable Resistive Transducers:** Principle of operation, construction details, characteristics and applications of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, Piezo-resistive sensor and humidity sensor.	**06L**
UNIT-04	**Variable Inductance Transducers:** Inductive transducers: Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, Variable reluctance transducers, Synchros, Microsyn.	**06L**
UNIT-05	**Variable Capacitance Transducers:** Principle of operation, construction details, characteristics of capacitive transducers, Different types and Signal Conditioning of capacitive transducers, Applications- Capacitor microphone, Capacitive pressure sensor, Proximity sensor.	**06L**
UNIT-06	**Others Transducers:** Piezoelectric transducer, Hall Effect transducer, Magneto elastic sensor, Digital transducers, Fiber optic sensors, Environmental Monitoring sensors (Water quality & Air pollution), Introduction to MEMS – Introduction to Smart transducers and its interface standard.	**06L**

Course Outcomes

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

CO1: Ability to analyze the problems related to transducers.
CO2: Ability to determine the static and dynamic characteristics of transducers.
CO3: Ability to analyze the problems related to transducers.

Books and References

1. Measurement Systems by E.O. Doebelin and D.N. Manik, McGraw-Hill Education Pvt. Ltd.
2. Instrument Transducers – An Introduction to Performance and Design by H.K.P. Neubert, Oxford University Press.
3. Transducers and Instrumentation by D.V.S. Murthy, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Sensors and Transducers by D. Patranabis, Prentice Hall of India Pvt. Ltd., New Delhi.

Course Name: **Non-Conventional Energy Resources**
Course Code: **EE-381**
Course Type: **Open Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To familiarize the students with general power scenario, various renewable energy technologies and grid integration of renewable energy resources.
- To familiarize the students with renewable energy sources like solar, geothermal, wind and fuel cell.
- To familiarize the students with thermos-electric power generation.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Energy Sources:** World energy futures, Conventional energy sources, Nonconventional energy sources, Prospects of Renewable energy sources.	**04L**
UNIT-02	**Solar Energy:** Introduction to solar radiation and its measurement, Introduction to Solar energy Collectors and Storage, Solar thermal electric conversion, Thermal electric conversion systems, Solar electric power generation, Solar photo-voltaic, Solar Cell principle, Semiconductor junctions, Conversion efficiency and power output, Basic photo-voltaic system for power generation.	**07L**
UNIT-03	**Wind Energy and Wind Energy Conversion:** Introduction to wind energy conversion, the nature of the wind, Power in the wind, Wind data and energy estimation, Site Selection considerations, basic Components of a Wind energy conversion system, Classification of WEC Systems, Schemes for electric generation using synchronous generator and induction generator, wind energy storage.	**08L**
UNIT-04	**Direct Energy Conversion Processes:** Magneto Hydro Dynamic Power Generation: Principles of MHD power generation, Open cycle systems, Closed cycle systems, Voltage and power output, Materials for MHD generators.	**05L**
UNIT-05	**Thermo-Electric Generation and Thermionic Generation:** Basic principles of thermo-electric power generation, Seebeck, Peltier, Thomson effects, Thermo-Electric power generator, and Analysis materials. Thermionic emission and work function, Basic thermionic generator.	**04L**
UNIT-06	**Thermo-Nuclear Fusion Energy and Fuel Cells:** The basic Nuclear Fusion and Fission Reactions Plasma confinement, Thermo-Nuclear function reactors. H_2, O_2 cells, classification of fuel cells, types, Advantages, Electrodes, Polarization.	**04L**
UNIT-07	**Energy from Biomass:** Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-gas plants, Biomass as a Source of Energy: Methods for obtaining energy from Bio-mass, Bio-logical conversion of Solar energy.	**04 L**

Course Outcomes

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

CO1: Analyze the energy scenario of the world and nation.
CO2: Carry out a comparative analysis of different types of coal, including their treatment, liquefaction and gasification.
CO3: Compare the liquid and gaseous fuels sourced from petroleum including their characterization.
CO4: Analyze the potential of alternate energy sources and their scope and limitations.
CO5: Solve energy related problems related to combustion and non-combustion.

Books and References

1. Renewable energy sources and conversion technology by N.K. Bansal, M. Kleemann, & M. Heliss, Tata McGraw-Hill.
2. Renewable Energy by S. Bent, Academic Press.
3. Renewable Energy: Power for a Sustainable Future by G. Boyle, Oxford University Press.