COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The mission of the Institute is to impart high quality education and training to its students to make them World-Class Engineers with a foresight to the changes and problems and pioneers to offer innovative solutions to benefit the nation and the world at large.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

To produce graduates with capabilities of Academic, Technical and Professional competences and to nurture them in the emerging fields of research, developing knowledge and skills towards innovation and product development.

MISSION

The mission of the Electrical and Electronics Engineering Program is

1. To foster the academic, technical and professional development of students through a broad-based technology oriented education.
2. To emphasize the application of current and emerging technologies to solve problems.
3. To design and develop products with creativity.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the Department Mission.

1) The electrical and electronics engineering program is designed to provide a strong educational back ground on which the candidates can build successful and sustainable careers in electrical engineering and other allied core field of specialization.
2) To familiarize the students in understanding the engineering problems and challenges and to provide engineering solutions viz., design, analysis, synthesis and methods of production and maintenance within engineering field so that they can compete in the global scenario.
3) An insight into contemporary issues and their implications to engineering practice by acquiring the mathematical and scientific knowledge needed to solve emerging real-world problems involving power, electronics, control systems, image analysis, signal processing and communication systems, ethically and responsibly, in order to serve the society.
4) Obtain a broad knowledge of electrical engineering to serve as a foundation for lifelong learning, and to achieve success in their professional career and/or advancement to graduate studies.
5) Emphasis on professional ethics, by developing creative and critical reasoning skills needed to provide solutions for industrial problems.
6) Develop communication skills necessary to bridge the gap between advanced technology and end users.
7) To gain the skills, confidence and experience to enable them to assume positions of technical and/ or managerial leadership in their career paths.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME OUTCOMES (POs)

At the end of the graduation, students in the Electrical and Electronics Engineering programme should possess :

S.No.	Graduate Attributes	PROGRAMME OUTCOME
PO1	**Knowledge - Basics**	To impart a solid foundation in mathematics, physical and life sciences, Social sciences and computer programming to enable successful completion of the undergraduate program.
PO2	**Critical - Thinking**	Build a broad engineering core competence to enable our students to approach problems systematically, to assess the reasonableness of new ideas and the value of new technology, and to make technology decisions with confidence. An ability to effectively treat complex electrical, electronic systems and signals through modeling, simulation, experimentation, interpretation and analysis of data.
PO3	**Problem - Solving**	Identify engineering problems, formulate descriptive models, and create, evaluate and synthesize solution by using the techniques, skills of modern engineering tools necessary for engineering practice. To inculcate an ability to build, test, and debug prototype circuits and systems and analyze results using the principles of design to solve open-ended engineering problems.
PO4	**Research - Skill**	Develop project-based learning skills through design and implementation of a system, component, or process that meets the needs within realistic constraints using the techniques, skills, and computer-based tools for conducting experiments and carrying out designs.
PO5	**Usage of Modern tools**	Construct and test hypotheses about system behavior by designing and conducting engineering experiments, analyzing and interpreting data and information.
PO6	**Multidisciplinary work**	An ability to design a component, a system or a process to produce desired outputs to meet desired needs with a blend of skills in civil, mechanical and electronics engineering.
PO7	**Project management**	An understanding through practical skills in the application of, the broad elements essential to successful engineering design: technical knowledge; multi-discipline teamwork; engineering standards; realistic constraints; such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
PO8	**Continuous Learning**	An understanding of contemporary issues and recognition of the need for, an ability to engage in life-long learning.
PO9	**Ethical Practices and social responsibility**	Ability to understand the responsibility of taking professional decisions based on the impact of socio- economical issues.

S.No.	Graduate Attributes	PROGRAMME OUTCOME
PO10	**Independent reflective learning**	Instill an optimistic self confidence, a high degree of personal integrity, and the belief that they can each make a difference. Bolster this self confidence by developing the professional competence outlined above, by developing persuasive communication skills in a variety of media by engaging them in team-based activities, and by strengthening their interpersonal skills.
PO11	**Collaborative Work**	An ability to apply the concepts of embedded systems in the development of industrial engineering.
PO12	**Leadership and Team Management**	Inculcate skills and confidence to assume positions of technical and/or managerial leadership in their career path.

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

B.E - ELECTRICAL AND ELECTRONICS ENGINEERING (FULL TIME)

Curriculum from the Academic Year 2013 - 2014 onwards

SUBJECTS OF STUDY

Semester III

S.No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1	13CE31	Mathematics III	3	1	0	4
2	13EE32	Network Analysis and Synthesis	3	1	0	4
3	13EE33	DC Machines and Transformers	3	0	0	3
4	13EE34	Electromagnetic Fields	3	1	0	4
5	13EE35	Electrical Measurements	3	0	0	3
6	13EE36	Linear Integrated Circuits	3	0	0	3
7	13EE37	DC Machines and Transformers Laboratory	0	0	3	2
8	13EE38	Linear Integrated Circuits Laboratory	0	0	3	2
9	13CE49	Science of Creativity and Professional Ethics	2	0	0	0
		Total Credits				**25**

Semester IV

S.No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1	13EE41	Mathematics IV	3	0	0	3
2	13EE42	Synchronous and Induction Machines	3	0	0	3
3	13EE43	Transmission and Distribution of Electrical Power	3	0	0	3
4	13EE44	Instrumentation Systems	3	1	0	4
5	13EE45	Digital Integrated Circuits	3	0	0	3
6	13EE46	Object Oriented Programming and C++	3	1	0	4
7	13EE47	Synchronous and Induction Machines Laboratory	0	0	3	2
8	13EE48	Digital Integrated Circuits Laboratory	0	0	3	2
9	13CE49	Science of Creativity and Professional Ethics	2	0	0	2
		Total Credits				**26**

Semester V

S.No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1	13EE51	Design of Electrical Machines	3	1	0	4
2	13EE52	Power System Analysis	3	1	0	4
3	13EE53	Control Systems	3	0	0	3
4	13EE54	Data Structures and Algorithms	3	1	0	4
5	13EE55	Computer Architecture and Organisation	3	0	0	3
6	13EE56	Microcontroller Based System Design	3	0	0	3
7	13EE57	Control Systems Laboratory	0	0	3	2
8	13EE58	Microcontrollers Laboratory	0	0	3	2
9	13EE69	Mini Project	0	0	3	-
		Total Credits				**25**

Semester VI

S.No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1	13EE61	Power Electronics	3	0	0	3
2	13EE62	Power System Protection	3	1	0	4
3	13EE63	Generation of Electrical Energy	3	0	0	3
4	13EE64	Digital Signal Processing	3	0	0	3
5	13EE65	Data Communication Networks	3	0	0	3
6	13EE66	Industrial Automation	3	0	0	3
7	13EE67	Power Electronics Laboratory	0	0	3	2
8	13EE68	Power Systems Laboratory	0	0	3	2
9	13EE69	Mini Project	0	0	3	2
		Total Credits				**25**

Semester VII

S. No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1.	13EE71	Electric Drives	3	0	0	3
2.	13EE72	Robotics and Control	3	0	0	3
3.	13EE73	Utilization and Conservation of Electrical Energy	3	1	0	4
4.	13EE74	Elective I	3	0	0	3
5.	13EE75	Elective II	3	0	0	3
6.	13EE76	Electric Drives Laboratory	0	0	3	2
7.	13EE77	Robotics and Control Laboratory	0	0	3	2
8.	13EE88	Project Work	0	0	6	-
		Total Credits				**20**

Semester VIII

S.No.	Subject Code	Course Title	L	T	P	C
	THEORY					
1	13EE81	Industrial Management and Economics	3	0	0	3
2	13EE82	Embedded Systems	3	0	0	3
3	13EE83	VLSI Design	3	0	0	3
4	13EE84	Elective III	3	0	0	3
5	13EE85	Elective IV	3	0	0	3
6	13EE86	VLSI Laboratory	0	0	3	2
7	13EE87	Embedded Systems Laboratory	0	0	3	2
8	13EE88	Project Work	0	0	6	6
		Total Credits				**25**

Grand Total Credits : 198

LIST OF ELECTIVES

S.No.	Subject Code	Course Title	L	T	P	C
1.	13ER01	Advanced Power Electronics	3	0	0	3
2.	13ER02	Cryptography	3	0	0	3
3.	13ER03	Design of Small Machines	3	0	0	3
4.	13ER04	Digital Control Systems	3	0	0	3
5.	13ER05	Digital Image processing	3	0	0	3
6.	13ER06	Electronic Product Design	3	0	0	3
7.	13ER07	Flexible AC Transmission Systems	3	0	0	3
8.	13ER08	High Speed Networks	3	0	0	3
9.	13ER09	High Voltage Transmission Systems	3	0	0	3
10.	13ER10	Linear and Non Linear Systems Theory	3	0	0	3
11.	13ER11	Low Power VLSI Design	3	0	0	3
12.	13ER12	Medical Electronics	3	0	0	3
13.	13ER13	Modeling and Analysis of Electrical Machines	3	0	0	3
14.	13ER14	Power Quality	3	0	0	3
15.	13ER15	Power System Control	3	0	0	3
16.	13ER16	Power System Economics	3	0	0	3
17.	13ER17	Restructured Power Systems	3	0	0	3
18.	13ER18	Smart Grid	3	0	0	3
19.	13ER19	Special Electrical Machines	3	0	0	3
20.	13ER20	Virtual Instrumentation	3	0	0	3

L - Lecture, T - Tutorial, P - Practical, C - Credit

13CE31 - MATHEMATICS- III

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

The objective is to incorporate the ideas of complex variables, partial differential equations and its applications and Fourier transforms that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

COURSE OUTCOMES

CO1 *: At the end of this course the students will be familiar in applying Complex variables ideas to solve Engineering problems, Partial differential equation ideas in modeling.*

CO2 *: The students will be able to solve Engineering problems and Fourier Transform ideas to analyze and solve communication oriented problems.*

CO3 *: They will be solving problems related with the above mentioned areas and can identify the areas in their discipline wherein these ideas could be directly applied.*

CO4 *: The students shall formulate and solve complex Differentiation and Integration in the field especially Mechanics of Materials, Thermodynamics, Heat Transfer, Mechanical Vibrations etc.*

COMPLEX DIFFERENTIATION

Analytic functions-Definitions and properties-Cauchy Riemann equations in cartesian and polar coordinates-construction of analytic functions- Conformal mappings-Bilinear Transformation -the mappings of the form w= z+a, az, 1/z, z2, ez, sinz, cosz, -Simple problems. **(12)**

COMPLEX INTEGRATION

Cauchy's integral theorem - Cauchy's Integral formula-Taylor's and Laurent's series (without proof)-Types of singularities, Poles and residues-Cauchy's residue theorem-Applications-Contour integration using circular and semicircular contours. **(12)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and functions-solution by direct method-solution of first order non-linear PDE-standard types-Lagrange's linear equation-Linear higher order homogeneous PDE with constant coefficients. **(12)**

FOURIER TRANSFORMS

Fourier integral theorem (without proof)-Infinite Fourier transform-infinite Fourier sine and cosine transforms-properties and problems-Convolution theorem-Parseval's identity-Finite Fourier sine and cosine Transforms- properties and problems. **(12)**

BOUNDARY VALUE PROBLEMS

Vibration of strings-one dimensional wave equations, one dimensional heat flow- unsteady state and steady state -Two dimensional heat flow steady state in Cartesian coordinates-Separation of variables-Fourier series solution. **(12)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Kandasamy, P.et al., "Engineering Mathematics", Volume - II & III S.Chand&Co. (2004).
2. Veerarajan .T, "Engineering Mathematics", (for Semester III), (Third Edition (Fifth Reprint) Tata McGraw-Hill publishing company Ltd (2008).
3. Venkataraman.M.K., "Engineering Mathematics III", (for B.E., Third Semester), (Revised and Enlarged Fourteenth Edition) The National Publishing Company - (2008).
4. Venkataraman.M.K., "Engineering Mathematics III-A",(Eleventh Edition) The National Publishing Company - (2008).

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", (8^{th} Edition) John Wiley & Sons (Asia) Private Limited., - (2008).
2. Grewal, B.S., "Higher Engineering Mathematics", (40^{th} Edition) Khanna Publishers - (2007).

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X											
CO2		X										
CO3			X			X						
CO4	X	X	X			X		X	X			

13EE32 - NETWORK ANALYSIS AND SYNTHESIS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the students basics of network topology and circuit transients, to make the students learn about analysis and synthesis of one port and two port networks and to study about filters and attenuators.

COURSE OUTCOMES

CO1 : *At the end of the semester the learner shall analyze any complex electrical network using basic circuit theory concepts.*

CO2 : *The students can evaluate the transient and steady-state behavior of electric circuits and synthesize an electrical network.*

CO3 : *Students will compute the complex power transfer between source and load. Also they will derive the source rating to match load and vice versa.*

NETWORK TOPOLOGY

Basic definitions of a network graph - oriented graph - sub graph - planar graph - path and circuit - tree and its properties - cut sets - incidence matrix - circuit matrix - cut set matrix - fundamental circuit or tie set matrix - fundamental cut - set matrix - duality and dual networks.

Network analysis using graph theory: Formation of network equations - network equilibrium equations on the basis of loop analysis - network equilibrium equations on the basis of node analysis - application to dc networks. **(9)**

CIRCUIT TRANSIENTS

Transient concepts - differential equations and initial conditions in RLC networks - transient response of simple RL, RC, and RLC series and parallel circuits to step and sinusoidal inputs using Laplace transform method-Natural frequency and damping factor. **(9)**

NETWORK FUNCTIONS AND TWO PORT NETWORKS

Concept of complex frequency - network functions - driving point and transfer functions and their properties - poles and zeros and their significance - time domain behavior from pole - zero plot - two port networks - Z, Y, ABCD, and h parameters - condition for reciprocity and symmetry - parameter conversion - interconnection of two port networks - analysis of typical two port networks - input and output impedances of terminated two port networks - image impedances. **(10)**

SYNTHESIS OF ONE-PORT NETWORKS

Hurwitz polynomials - positive real functions - frequency response of reactive one ports - synthesis of reactive one ports - synthesis of RL and RC one-port networks. **(8)**

FILTERS AND ATTENUATORS

Introduction - propagation constant - decibel and neper - classification of filters - filter networks - equations of filter networks - low pass, high pass, band pass, and band elimination filters - limitations of constant k

filters - m - derived filters - composite filter. Attenuators:T type, π type, lattice, bridged T, and L type attenuators. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Franklin F. Kuo, “Network Analysis and Synthesis” Wiley India Pvt. Ltd., New Delhi, II Edition, 2012.
2. Roy D.Choudhury, "Networks and Systems", New Age Publications, New Delhi, IV Edition, 2010.

REFERENCE BOOKS

1. Jagan N.C., and Lakshminarayana C., "Network Theory", BS Publications, Hyderabad, 2005.
2. Sudhakar A. and Shyammohan S.P., "Circuits and Networks: Analysis and Synthesis", TMH, New Delhi 2011.
3. Joseph A. Edminister and MahmoodNahvi, "Electric Circuits", Schaum's Series, TMH, New Delhi 2011.
4. Chakrabarti A., "Circuit Theory : Analysis and Synthesis"., Dhanpat Rai & Co. (Pvt) Ltd, VI Edition, New Delhi, 2014.
5. Paranjothi. S.R. “Electric Circuit Analysis” New Age International (P) Ltd., IV Edition, New Delhi, 2010.

TUTORIALS

1. Transient and steady state analysis of first order circuits
2. Transient and steady state analysis of II order circuits
3. Network functions of one port networks
4. Z-parameters of two-port network
5. Y-parameters of two-port network
6. H-parameters of two-port network
7. Synthesis of one port networks
8. Characteristics of filters
9. Study of attenuators
10. Analysis using graph theory

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X									
CO2	X	X										
CO3	X		X									

13EE33 - DC MACHINES AND TRANSFORMERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the fundamentals of energy conversion, generation of DC voltage and to study the construction, principle of operation, characteristics and testing of DC machines and Transformers.

COURSE OUTCOMES

CO1 *: Students shall understand the concepts of static and dynamic electric machines and the principle of electromagnetism.*

CO2 *: The students will be aware of the construction and working, study the characteristics and applications of DC machines and Transformers.*

CO3 *: Students will analyse and compute the performance characteristics of DC machines and transformer for the different level of utilization in Industries.*

DC MACHINES

D.C. Machines- construction -principle of operation- methods of excitation- Armature Winding- Armature reaction- Effect of brush shift- commutation. **(9)**

DC GENERATORS AND DC MOTORS

D.C. Generators: EMF equation -magnetization characteristics- internal and external characteristics- parallel operation- applications.

D.C. Motors: Types - Torque equation- Circuit models-electrical and mechanical Characteristics-starters - speed control methods- Electric braking - applications. **(9)**

TESTING OF DC MACHINES

Losses and efficiency- Testing: Direct, indirect and regenerative methods to test DC machines- separation of losses by single motor and auxiliary motor. **(9)**

TRANSFORMERS

Construction and types - Principal of operation - EMF equation - phasor diagram-equivalent circuit-voltage regulation- losses and efficiency-. All day efficiency - Parallel Operation Testing: Open and short circuit tests, Polarity test, Sumpner's test - Separation of hysteresis and eddy current losses. **(9)**

AUTOTRANSFORMERS AND THREE PHASE TRANSFORMERS

Autotransformers : Construction - Principle - Applications and comparison with two winding transformer. Three phase Transformer : Types of connections and their comparative features - Excitation phenomenon in transformers-Harmonics in single phase and three phase transformers - Scott connections - OFF load and ON load tap changing of transformers- Cooling methods of transformers - Instrument transformers. **(9)**

TOTAL : 45

TEXT BOOKS

1. Nagrath, I.J. and Kothari D.P., "Electrical Machines" , Tata Mc Graw Hill Publishing Company Ltd., New Delhi, Fourth Edition,Third reprint 2011.
2. Smarajit Ghosh., "Electrical Machines I," Pearson Education in South Asia, 2012

REFERENCE BOOKS

1. Bhattacharya. P.S., "Electrical Machines", Tata Mc Graw Hill, Third edition, 2008.
2. Say. M.G., “Alternating Current Machines”, ELBS & Pitman, London, 1983,
3. A.F. Puchsteint, “Alternating Current Machines” TC-LLOYD, Third Edition, Asia Publishing House.
4. Rajput R.K. "Electrical Machines", Laxmi Publications (P) Ltd., New Delhi, 2006.
5. Deshpande. M.V. "Electrical Machines", PHI Learning Pvt., Ltd. 2011.
6. B.L.Theraja, A.K. Theraja, "A Text book of Electrical Technology" , Volume 2, S. Chand Publisher, 2012.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X									
CO2	X	X	X			X		X				
CO3	X	X	X			X		X				

13EE34 - ELECTROMAGNETIC FIELDS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart knowledge and understand the basic concepts of electrostatics, magnetostatics, electrodynamics fields and electromagnetic waves.

COURSE OUTCOMES

CO1 : *Upon completion of this course, student shall apply the laws of electrostatics and electromagnetics in the study of electrical machine theory and power line parameter calculations.*

CO2 : *The learner will analyze various geometries of conductors, charge distributions and to determine the terminal behavior of capacitors and inductors.*

CO3 : *Students will have exposure to the fundamentals of wave propagation and to acquire knowledge in the simulation of field distributions for a given configuration.*

ELECTROSTATIC FIELDS

Types of charge distributions - Coulomb's law - electric field intensity of point, line and sheet of charges - electric flux density - Gauss's law and its applications - divergence theorem - Poisson's and Laplace equations - electric potential - potential gradient. **(9)**

ELECTRIC FIELD IN MATERIALS

Properties of Conductors - Current and current density - continuity of current - relaxation time- nature of dielectric materials - polarization in dielectrics- boundary conditions for perfect dielectric materials - electric dipole - Potential and field due to an electric dipole - capacitance - determination of capacitance for different configurations - electrostatic energy storage and energy density. **(9)**

MAGNETOSTATIC FIELDS

Lorentz law of force- BiotSavart's law and its applications - Ampere's circuital law and its applications - Stoke's theorem - magnetic flux and flux density - scalar and vector magnetic potential - Relation between field theory and circuit theory. **(8)**

MAGNETIC FORCE AND INDUCTANCE

Force between different current elements- Torque on closed circuits -Magnetization - Magnetic boundary conditions - Inductance - Inductance of Solenoids, Toroids, Transmission lines and Cables- Mutual Inductance - Magneto-static energy storage and energy density -Lifting force of a magnet . **(10)**

ELECTRODYNAMIC FIELDS AND ELECTROMAGNETIC WAVES

Faraday's law -Stationary and motional emfs - conduction and displacement current densities - Maxwell's equations in differential and integral forms.Electromagnetic waves: wave equations - wave parameters: velocity, intrinsic impedance and propagation constant- waves in free space, conductors, lossy and lossless dielectrics- skin depth- Poynting vector and Poynting's theorem. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. W.H.Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill, New Delhi, 2011.
2. Gangadhar K.A. and Ramanathan P.M., "Electromagnetic Field Theory", Khanna Publishers, Delhi, 2011.

REFERENCE BOOKS

1. John D. Kraus and Daniel A. Fleisch, "Electromagnetics with Applications", V Edition, Tata McGraw Hill, 2010.
2. Joseph A. Edminister, "Theory and Problems of Electromagnetics", Schaum's Outline Series, Tata McGraw Hill Inc.,New Delhi, 1993.
3. AshutoshPramanik, "Electromagnetism - Theory and Applications", Prentice Hall of India, New Delhi, 2006.
4. N.N.Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India, New Delhi, 2003.
5. Matthew N.O.Sadiku, “Elements of Electromagnetics”, Oxford University Press, 2010.
6. http://nptel.iitm.ac.in
7. http://openems.de/start/index.php

TUTORIALS

1. Applications of Coulomb's law.
2. Determination of Electric potential and potential gradient.
3. Applications of Boundary conditions for perfect dielectric materials.
4. Determination of capacitance for different configurations.
5. Applications of Biot Savart's law.
6. Applications of Ampere's circuital law.
7. Determination of Force between different current elements.
8. Applications of Magnetic boundary conditions.
9. Determination of Inductance.
10. Determination of Conduction and displacement current densities.
11. Applications of Maxwell's equations.
12. Determination of Wave parameters.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X				X						
CO2		X	X			X						
CO3		X	X			X						

13EE35 - ELECTRICAL MEASUREMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

The students can acquire knowledge and good understanding of the principles of measurement including the characteristics of measurement devices, types of errors, electrical noise, calibration and measurement of all electrical quantities. The students should have good overview of the measurement techniques involved in the equipment used. They also know about the usage of sophisticated electrical and electronics measuring instruments like power quality analyzer, mixed storage oscilloscope, true rms meter.

COURSE OUTCOMES

CO1 *: The students have acquired knowledge about the basic function, operation, selection, response behavior, and sources of error in common measuring instruments for measuring various electrical and non- electrical physical quantities.*

CO2 *: The learners can handle the measuring equipment, instrument transformers, sophisticated instruments like digital storage oscilloscope, harmonic analyzer and spectrum analyzer in the laboratory.*

CO3 *: Student will choose the right instrument for measuring any electrical parameter with better accuracy during field measurements.*

INTRODUCTION

Functional Element of Generalized Measurement System - Static and Dynamic Characteristics - Measurement Standards - Statistical Analysis and Errors in Measurements - Applications - Classification of Measurements - Calibration. **(9)**

MEASUREMENTS OF ELECTRICAL QUANTITIES

Measurement of Voltage and Current - PMMC Instruments - Moving Iron Instruments - Dynamometer Type Wattmeter - Instrument Transformers - Induction Type Energy Meter - Errors in Energy Meter. Measurement of R, L and C - Wheatstone, Kelvin, Maxwell, Anderson and Schering Bridges - Hays Bridges. **(9)**

GALVANOMETER, MAGNETIC MEASUREMENTS

Flux Meter - Determination of BH Curve and Hysteresis Loop of Ring and Bar Specimens (Double Bar Method Only) - Iron Loss Measurement by Magnetic Squares - Maximum Demand Indicator - Electrodynamometer Power Factor Meter - Frequency Meter - synchro scope. **(9)**

DIGITAL MEASUREMENT TECHNIQUES

Digital Voltmeter - Digital Multimeter- True RMS meter - Digital Frequency Meter - Network Analyzer- Spectrum Analyzer - Power Quality Analyzer -Distortion Factor Meter - Megger - Introduction to Digital Clamp Meter. **(9)**

DISPLAY DEVICES AND RECORDERS

Display Devices: Seven Segment Display - LED - LCD - Recorders- Galvanometer Type Recorders - Potentiometer Recorders - X-Y Recorder - Magnetic Tape Recorder. **(9)**

TOTAL : 45

TEXT BOOKS

1. A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", DhanpatRai and Sons, New Delhi, 2011.
2. Ernest O.Doeblin, "Measurement Systems - Applications and Design", McGraw Hill, 1975.

REFERENCE BOOKS

1. H.S.Kalsi, "Electronic Instrumentation", 3rd Edition, Tata McGraw Hill Co., 2012.
2. A.D.Cooper and A.D.Helfrik, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, New Delhi, 1997.
3. S.Ramabhadran, "Electrical Measurements and Instruments", Khanna Publishers, New Delhi, 1984.
4. S.K.Singh,"Industrial Instrumentation and Control", Tata McGraw Hill Publishers, New Delhi, 2003, 2nd Edition.
5. Roman Malaric, “Instrumentation & Measurement in Electrical Engineering”, Brown Walker Press, Florida, USA, 2011.
6. David A. Bell, “Electronic Instrumentation & Measurements”, Oxford University Press, 2nd Edition, 2009.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X			X						
CO2				X								
CO3				X		X						

13EE36 - LINEAR INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To make the students to understand the basic principle of operational amplifiers, its applications and design.

COURSE OUTCOMES

CO1 : *This course will pave the way to design amplifiers, comparators, converters and different types of filters using IC 741, power supply using IC 723, any application circuits with IC 555 Timer and PLL.*

CO2 : *The learners will have the real time understanding of designing power supplies, amplifier, oscillator, signal conditioning circuits, combinational circuits and sequential circuits for the given requirements.*

CO3 : *The learner can design any system using analog ICs for Industrial Applications.*

INTEGRATED CIRCUIT TECHNOLOGY

Silicon Semiconductor Technology -wafer processing, oxidation, epitaxy, deposition, ion implantation diffusion and metallization - basic CMOS processing technology - n-well, p-well process, twin - tub process and silicon on insulator - Circuit Elements - Resistors, Capacitors and Thin film transistors. **(9)**

OPERATIONAL AMPLIFIER CHARACTERISTICS

Functional block diagram - analysis of typical op-amp - equivalent circuit - open loop gain - CMRR - input bias and off set currents - input and output off set voltages - off set compensation techniques - frequency response - noise -stability - limitation - frequency compensation techniques - slew rate. **(9)**

OPERATIONAL AMPLIFIER APPLICATIONS

DC and AC Amplifier - voltage follower - summing, scaling and averaging amplifier - inverting and non inverting amplifier - differential amplifier - instrumentation amplifier - voltage to current and current to voltage converters - integrator and differentiator - practical considerations - active filters and oscillators. **(9)**

COMPARATORS AND CONVERTERS

Comparator- zero crossing detector - Schmitt trigger - voltage to frequency and frequency to voltage converters - sample and hold circuit - D/A converters - A/D converters - precision rectifiers - peak detectors - clipper and clamper - log and antilog amplifier - multiplier and divider - wave form generators. **(9)**

OTHER LINEAR IC APPLICATIONS

Voltage regulators - IC 723 - current limiting and current boosting - fixed and adjustable - three terminal regulators - SMPS - PLL - applications - power amplifiers - IC 566 voltage controlled oscillators - IC 555 timer - monostable and astable mode of operations - applications. **(9)**

TOTAL : 45

TEXT BOOKS

1. Ramakant A.Gayakward, "Op-Amps and Linear Integrated Circuits", IV Edition, Prentice Hall of India, New Delhi, 2007.
2. Coughlin F.R. and Driscoll F.F., "Operational Amplifiers and Linear Integrated Circuits", VI Edition, Prentice Hall of India, New Delhi, 2001.

REFERENCE BOOKS

1. Roy Choudhury D. and Shail Jain., "Linear Integrated Circuits", IV Edition, New Age Science Ltd., 2010.
2. Sergio Franco, "Design with Operational Amplifiers and Analog and Integrated Circuits", III Edition Tata McGraw Hill Publishing Co., New Delhi, 2007.
3. Michael Jacob J., "Analog Integrated Circuit Applications", I Edition, Prentice Hall of India, New Delhi, 2000.
4. Sidney Soclof, "Design & Application of Analog Integrated Circuits", Prentice Hall of India, 1997.
5. David A. Bell, “Operational Amplifiers and Linear ICs”, Oxford University Press, 2011.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X	X								
CO2				X								
CO3				X		X						

13EE37 - DC MACHINES AND TRANSFORMERS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To give hands on training for measuring DC /AC electrical parameters using instruments on static and dynamic electro mechanical energy conversion devices through conducting basic tests on DC machines and transformers and to study their performance.

COURSE OUTCOMES

CO1 : *The learners will understand the basic concepts in DC machines and transformers and their constructional details.*

CO2 : *Student will analyze the performance of DC machines and transformers using different tests.*

CO3 : *Student will select the suitable rating of DC machine and transformer for the given industry application.*

LIST OF EXPERIMENTS

1. OCC and Critical Speed of DC Generator
2. a) No Load Speed Control of DC Shunt Motor
   b) Swinburne's Test
3. Load Test on DC Shunt Motor
4. Load Test on DC shunt Generator
5. Load Test on DC Series Generator
6. Load Test on DC Series Motor
7. Load Test on DC Compound Generator
8. Load Test on DC Compound Motor
9. Hopkinson's Test
10. OC and SC Test on Single - Phase Transformer
11. Load Test on Single - Phase Transformer
12. Load Test on Scott-Connected Transformer
13. Sumpner's Test
14. Study on Three Phase Transformers

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)												
COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X		X	X		X						
CO2	X	X		X		X						
CO3	X	X		X				X				

13EE38 - LINEAR INTEGRATED CIRCUITS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : THEORY

COURSE OBJECTIVE

To inculcate the students the skills pertaining to the design of any electronic circuit with linear ICs for the given design specifications.

COURSE OUTCOMES

CO1 : *The Learners will know the design techniques of DC power supply for any electronic circuits.*

CO2 : *The Students will analyze the performance and characteristics of linear ICs and know to select proper IC's for the given control applications.*

CO3 : *The Students will design amplifier, oscillator, signal conditioning circuits and any analog circuit for the given requirements.*

LIST OF EXPERIMENTS

1. DC and AC Characteristics of Operational Amplifier.
2. Linear applications of Operational Amplifier.
3. Design of Active Filters.
4. IC 555 Timer Applications.
5. Precision Rectifier and Zero Crossing Detector.
6. Instrumentation Amplifier.
7. Waveform Generators (Square, Triangle and Ramp).
8. Voltage Controlled Oscillator
9. Analog to Digital Converters and Digital to Analog Converters
10. Design of Regulated Power Supply.
11. Voltage to current converter and current to voltage converter.
12. Frequency to voltage converter and voltage to frequency converter.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X			X	X		X				
CO2				X		X		X				
CO3		X	X		X							

13EE41 - MATHEMATICS-IV

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

The objective is to incorporate the basic Numerical methods required for solving Engineering problems and also to study the basic Statistical ideas, Random process and Vector spaces that are imperative for effective understanding of Engineering subjects. The topics introduced will serve as basic tools for specialized studies in many Engineering fields.

COURSE OUTCOMES

CO1 : *The students will be familiar in the ideas of applying numerical methods for solving system of equations.*

CO2 : *The students will know the two dimensional random variables and curve fitting and how these designs are used to test the various attributes in Engineering and Technological Applications.*

CO3 : *The students will know about the concept of Random Processes, Meaning, Properties, Importance and applications of them.*

CO4 : *The students will know about the concepts in vector spaces, Linear transformation, Inner Product space and analyse the engineering problem.*

NUMERICAL METHODS - I

Linear simultaneous equations : Gauss elimination method - Gauss Jordan elimination method - Crout's method - Gauss Seidal method - Relaxation method.

Ordinary differential equations : Taylor's series - Modified Euler's - Runge- kutta fourth order methods - Milne's predictor - corrector method. **(9)**

NUMERICAL METHODS - II

Finite difference approximations - solution of second order PDE - Laplace equation - Liebmanns iteration process - Poisson equation - Parabolic equation - Bender Schmidt and Crank - Nicholson methods - Hyperbolic equation - explicit method. **(9)**

TWO DIMENSIONAL RANDOM VARIABLES

Probability mass function - Probability distribution function-Cumulative distribution function-Marginal probability functions-Conditional distribution-Expectation of two dimensional random variables-Covariance-Correlation-regression-curve fitting-least square technique-only curve of the form or reducible to the forms $y = ax + b$ & $y = ax^2 + bx + c$ **(9)**

RANDOM PROCESSES

Classification of random processes-Special classes of Random processes-Average values of Random processes - Stationarity - Analytical representation of random processes-Auto correlation function and its properties-Cross-Correlation function and its properties-Ergodicity-Mean Ergodic theorem - Correlation Ergodic process-Distribution Ergodic process-Power spectral density function and its properties. **(9)**

VECTOR SPACES & LINEAR MAPPING

Definition of vector spaces-linear dependence and independence-sub spaces-Basis and dimension of vector space-Representation of linear maps by matrices-rank and nullity of linear transformation.-Inner product space-properties-Cauchy Schwartz inequality- norm and its properties- Introduction of orthogonal basis and Gram-Schmidt-orthogonalization process. **(9)**

TOTAL : 45

TEXT BOOKS

1. Kandasamy. P., "Numerical Methods", S.Chand and Company (2008).
2. Veerarajan T, " Probability Statistics and Random Process', (Third edition) (2007) Tata McGraw Hill Publishing company Ltd.
3. Venkataraman M.K, "Higher Mathematics for Engineering and Science" National Publishing Company (2000).
4. Krishnamurthi V., et al., "An Introduction to Linear Algebra", Affiliated East West Press (2004).

REFERENCE BOOKS

1. Kapoor.J.N and Sabena. H.C., "Mathematical Statistics" (12th Edition), S Chand and Compnay (2003).
2. Grewal.B.S.,"Higher Engineering Mathematics" (40th Edition) Khanna Publishers (2007).
3. Kenneth Hoffman and Ray Kunze 'Linear Algebra", (Second Edition) (Third Imprint) Pearson Education, Prentice Hall (2008).
4. Stephen, H and Friedberg, "Linear Algebra", Prentice Hall of India (PHI) (2003).
5. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jercy (2003).

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X					X				
CO2	X	X								X		
CO3	X	X		X			X				X	
CO4	X	X				X						

13EE42 - SYNCHRONOUS AND INDUCTION MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To study about the construction, principle of operation and performance of alternators, synchronous motors, single phase and three phase induction motors, various starting methods, speed control of three phase induction motor and single phase induction motors.

COURSE OUTCOMES

CO1 *: The students will be able to describe the operation and characteristics of synchronous and induction machines.*

CO2 *: The student will be able to select suitable motor for any specific application.*

CO3 *: The student will be able to implement speed control methods for various motor.*

SYNCHRONOUS GENERATOR

Constructional features - Generated emf-phasor diagram-armature reaction-synchronous impedance - emf,mmf & potier method of voltage regulation-Parallel operation of Alternators-Synchronization and load division -Two reaction theory-analysis of phasor diagram-power angle characteristics- determination of Xd and Xq. **(9)**

SYNCHRONOUS MOTOR

Operating principle - circuit model - phasor diagram - effect of load. Operating characteristics of synchronous machines - V and inverted V curves - starting methods of synchronous motors. **(9)**

THEORY AND OPERATION OF THREE PHASE INDUCTION MOTORS

Constructional features-production of torque - phasor diagram - equivalent circuit - performance analysis-torque-slip characteristics-Testing: no load and blocked rotor test, load test- Effect of rotor resistance-circle diagram. **(9)**

STARTING, SPEED CONTROL AND BRAKING OF INDUCTION MOTORS

Starting: Starting methods of squirrel cage and wound rotor induction motor-Speed Control: Various methods of speed control of squirrel cage and wound rotor induction motor-Crawling- Cogging- Methods of Electric Braking - Induction Generator (Qualitative treatment only). **(9)**

SINGLE PHASE INDUCTION MOTORS

Principle of operation of single phase induction motor - double revolving field theory - equivalent circuit - determination of equivalent circuit parameters and performance characteristics - methods of starting - capacitor start, capacitor start and run, shaded pole and repulsion motors - universal motor. **(9)**

TOTAL : 45

TEXT BOOKS

1. M.G.Say, "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors, New Delhi, 2002.
2. I.J.Nagarath and D.P.Kothari, "Electrical Machines", Tata McGraw Hill, Fourth Edition, 2011.
3. A.E. Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, “Electric Machinery” Tata Mc Graw Hill, 6th Edition, 2003.

REFERENCE BOOKS

1. S.K Bhattacharya, "Electrical Machines", McGraw Hill, New Delhi, 2008.
2. P.K.G. Mukherjee and S.Chakrabarthi, "Electrical Machines", Dhanpat Rai and Sons, New Delhi, 1990.
3. P.S. Bhimbra, "Electrical Machinery", Khanna Publishers,2003.
4. Cyrill. G. Veinott, "Fractional and Subfractional Horse Power Electric motors", McGraw Hill Publishers, 1996.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X					X		X		
CO2	X	X				X		X			X	
CO3	X	X	X	X						X		

13EE43 - TRANSMISSION AND DISTRIBUTION OF ELECTRICAL POWER

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the essentials of interconnected electric power systems. To give a comprehensive overview of the terminology, electrical concepts, design considerations, construction practices, operational aspects of transmission and distribution systems.

COURSE OUTCOMES

CO1 : *Upon completion of the course the students will be able to model a transmission line, analyze the performance of power transmission systems.*

CO2 : *The students will be able to apply the tariff calculations for consumers and the latest trends in substation automation.*

CO3 : *The students will be able to design a layout for distribution and substation systems with the implementation of necessary automation protocols.*

INTRODUCTION

Introduction to EHV AC and HVDC transmission - comparison between HVAC and HVDC - overhead and underground transmission scheme - HVDC systems - Comparison of Copper efficiencies of various systems.

Line Parameters : Resistance of conductors - skin effect - inductance of a conductor due to internal and external flux -- inductance and capacitance of single-phase two-wire line, three phase lines with symmetrical and unsymmetrical spacing, bundled conductor lines and double circuit three phase lines -effect of earth on line capacitance. **(9)**

LINE PERFORMANCE AND CORONA

Regulation and efficiency short lines - medium lines represented by nominal T and Π methods - long lines - rigorous solution - ABCD constants - Ferranti effect - tuned power lines- power flow through a transmission line - power circle diagrams.

Phenomenon of corona - disruptive critical voltage - visual critical voltage - corona loss - radio frequency interference. **(9)**

INSULATORS AND MECHANICAL DESIGN OF OVERHEAD LINES

Insulator materials - insulator types - voltage distribution over insulator string - methods of improving string efficiency - insulator failure - testing of insulators.

Line supports - types of steel towers - cross arms - span, conductor configuration, spacing and clearances - sag and tension calculations- effect of wind, temperature and ice - support at different levels - stringing chart - conductor vibration. **(9)**

UNDERGROUND CABLES

Comparison between overhead line and underground cable for transmission - types of cables - types of insulating materials - insulation resistance - potential gradient - grading of cables - capacitance of single

and three core cables - faults and fault location by loop test - cable installation - current rating of cables - operating problems with underground cables. **(9)**

DISTRIBUTION SYSTEMS AND SUBSTATIONS

AC distribution - Radial and ring main systems - ring main distributors with interconnectors - methods of solving AC distribution systems. Tariff calculations: two part tariff - Grid Tariff.

Substation - types of substations - layout and location of substations - busbar arrangements - Introduction to substation automation protocols. **(9)**

TOTAL : 45

TEXT BOOK

1. C.L.Wadhwa, "Electrical Power Systems", New Age International, 2010.

REFERENCE BOOKS

1. Luces M.FualKeribeery, Watter Coffer, “Electrical power Distribution and Transmission”, Pearson Education, 1996.
2. J.Nagrath and D.P.Kothari, "Power Systems Engineering", Tata McGraw Hill, 2007.
3. Dr. S.L.Uppal, "Electrical Power", Khanna Publishers, 1988.
4. M.L. Sony, P.V.Gupta, V.S Bhatnagar and A.Chakraborti, "A Text Book on Power Systems Engineering", Dhanpat Rai and Co., Delhi, 1997-98.
5. TorenGonen, " Electrical Power Distribution", CBC, 2010

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X		X					
CO2	X	X	X					X	X			
CO3	X	X		X	X					X	X	

13EE44 - INSTRUMENTATION SYSTEMS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

The students can acquire knowledge and good understanding of the principles of instrumentation system to measure electrical and non-electrical quantities using various transducers like displacement, force, torque, pressure etc.. Students also can get sound knowledge about the characteristics of transducers, choice of transducers, types of errors, electrical noise, calibration and measurement of all electrical quantities. The students should have good overview of the measurement techniques involved in the equipment used.

COURSE OUTCOMES

CO1 *: With the basic function, operation, selection, response behavior, and sources of error in transducers, the students can choose transducers for any specific application.*

CO2 *: The students can implement sensors suiting a particular application and the data handling could be effectively made.*

CO3 *: The students can effectively utilize mixed signal oscilloscope, multichannel storage oscilloscope in engineering application.*

INTRODUCTION TO TRANSDUCERS, MODERN SENSORS

Functional Elements of an Instrumentation System - Static and Dynamic Characteristics - Factors influencing choice of Transducers - Principles and classification of Transducers- Electrical Transducers- Basic requirements of Transducers -Standards - Category Rating - Calibration-Applications - Measurement of Nanostructure- Micromachined -Electro-Mechanical Sensors (MEMS) - Smart Sensors and System on Chip. **(9)**

STRAIN, DISPLACEMENT, FORCE AND TORQUE MEASUREMENT

Introduction-Factors affecting Strain Measurement- Bonded and Unbonded Strain Gauges -Gauge Factor-Resistive Potentiometers - L.V.D.T- Variable Inductance and Capacitance Transducers - Piezo Electrical Transducers- Hall Effect Transducer - Opto Electronic Transducers - Digital Encoding Transducers-Introduction-Load Cell-Effect of Temperature Variations-Dynamic Response-Digital Force Transducer-Torque Measurement - Torque cell. **(9)**

MEASUREMENT OF VIBRATION, FLOW, TEMPERATURE AND PRESSURE

Introduction - Characteristics of Vibration-Vibration Measurement - Seismic Transducer - Calibration - Classification of Flow Meters - Electromagnetic Flow Meter - Anemometers- Ultrasonic Flow Meters - Introduction to Temperature Measurement - Resistance Thermometers - RTD - Thermocouples - Thermistor - Application- Types of Pressure Measurement Devices - Pressure cell. **(9)**

ELECTRONIC MEASURING INSTRUMENTS

Analog CRO, Digital Storage Oscilloscope - Bistable Storage Oscilloscopes-Fast Storage Oscilloscopes -Multichannel Storage Oscilloscope - Mixed Signal Oscilloscope. Signal Generator - Function Generator - Introduction to Arbitrary Waveform Generator. **(9)**

PC INTERFACING AND DATA ACQUISITION

Signal Conditioning - Data Transmission - Telemetry - Introduction to Data Acquisition - software consideration - Sensors and interfacing - sampling, quantization, noise and filtering - I/O techniques - Serial communications- scaling and linearization. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", DhanpatRai and Sons, New Delhi, 2011.
2. Kevin James, "PC Interfacing and Data Acquisition" Elsevier, Newnes, 2000.

REFERENCE BOOKS

1. Ernest O.Doeblin, "Measurement Systems - Applications and Design", McGraw Hill, 2009.
2. D.V.S. Murty, "Transducers and Instrumentation", Prentice-Hall of India, New Delhi, 2000.
3. Dr.AlSutko, Dr. Jerry D. Faulk, "Industrial Instrumentation" Cengage Learning, India Edition, 2011.
4. K. Krishnaswamy, S. Vijayachitra, "Industrial Instrumentation" New Age International Publishers, 2012.

TUTORIALS

1. Study of CT & PT
2. Extension of range of ammeter & voltmeter
3. Measurement of displacement using LVDT
4. Study of Inductive and Capacitive transducer
5. Measurement of temperature using temperature transducer
6. To study the working of Bourdon Pressure Gauge Transducer
7. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.
8. To measure the stress & strain using strain gauges.
9. Vibration measurement by Dual Trace Digital storage Oscilloscope.
10. Unknown frequency measurement of a signal using CRO.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X			X		X	X	X		
CO2	X	X		X			X					
CO3	X				X	X		X			X	

13EE45 - DIGITAL INTEGRATED CIRCUITS

L	T	P	C

ASSESSMENT : THEORY

COURSE OBJECTIVE

To aspire the students the fundamental concepts of digital electronic circuits and make them to learn the design procedure of digital system using integrated circuits.

COURSE OUTCOMES

CO1 : *The learner will be able to design any combinational circuit using logic gates, multiplexers and decoders.*

CO2 : *The learners will have the real time understanding of designing and analyzing synchronous and asynchronous sequential circuits for the given requirements.*

CO3 : *The learners will design any digital system using digital IC's and can perform various testing for fault analysis.*

NUMBER SYSTEM & DIGITAL LOGIC FAMILIES

Review of number systems - conversion methods- computer codes - error detection and correction codes Digital Logic Families - TTL, ECL, MOS and CMOS - characteristics - comparison of performances - speed, fan-in, fan-out, propagation delay, power dissipation and noise margin **(9)**

COMBINATIONAL LOGIC CIRCUITS

Switching functions - representation of logic functions - canonical forms - sum of products and product of sums - simplification - Karnaugh-map and QuineMcCluskey minimization techniques - Design of combinational logic circuits using logic gates - multiplexers and demultiplexers - decoders and encoders - parity generators and checkers - code converters - comparators - adders and-subtractors - BCD adders and subtractors. **(9)**

SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS

Flip Flops - counters - asynchronous and synchronous type - modulo counters - shift registers - ring and twisted ring counters - frequency counters and Digital clock. Mealy and Moore Machines - state table and excitation table - state diagram - state reduction - state assignment - synthesis and analysis of synchronous sequential circuits. **(9)**

ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS

Transition table - flow table - reduction of state - minimization of completely specified machines and incompletely specified machines -implication table - merging of flow table - race free state assignment - Design and analysis of asynchronous sequential logic circuits - Logic circuit implementation using programmable logic devices. **(9)**

DIGITAL SYSTEM TESTING

Combinational logic hazards - fault detection and redundancy - testing for single stuck faults and multiple faults - method of testing - fault tables, Boolean difference, path-sensitization ENF and SPOOF methods - random test - design for testability - built- in self test -boundary scan - automatic test pattern generation - IDDQ test. **(9)**

TOTAL : 45

TEXT BOOKS

1. Morris Mano, "Digital Design", IV Edition, Prentice Hall of India Ltd., 2007.
2. Miron Abrammovici, Melvin Breuer, "Digital System Testing and Testable Design", Jaico Publishing House, 2010.

REFERENCE BOOKS

1. Ronald J.Tocci, "Digital Systems - Principles and Applications", 11th Edition, Prentice Hall of India Ltd., 2011
2. John M.Yarbrough,"Digital Logic Applications and Design", PWS, 2001.
3. Palmer J.E., "Introduction to Digital Systems", Schaum's Outline Series, Tata McGraw Hill, New Delhi, 1996.
4. Richard F.Tinder, "Engineering Digital Systems Design", Harcourt India Pvt. Ltd., New Delhi, 2001.
5. John P.Uyemura,"A First Course in Digital Systems Design - An Integrated Approach", Brooks/Cole Publishing Company, 2000.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X	X				X				
CO2		X	X			X	X		X		X	
CO3		X			X					X		

13EE46 - OBJECT ORIENTED PROGRAMMING AND C++

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To familiarize the students about the object oriented programming paradigm using C++ and to make the learners to model the problems and to develop and test codes for them in object oriented paradigm.

COURSE OUTCOMES

CO1 : *Show evidence of a systematic and comprehensive understanding of object-oriented principles by producing a design that meets identifiable requirements and standards.*

CO2 : *Adapt approaches including some at the forefront of the discipline and identify possibilities for originality or creativity.*

CO3 : *Use appropriate development tools and processes to create, debug, test and optimize an efficient, robust, real-time, C++ application based on an object-orientated design.*

CO4 : *Have a critical awareness and be able to participate within the professional, legal and ethical frameworks for software development.*

PRINCIPLES OF OOP

Programming Paradigms-Object Oriented Technology-Basic concepts and benefits of OOP-Application of OOP- OOP languages.

Introduction to C++:Basic data types-Derived data types- Symbolic constants-Scope resolution operator-Type modifiers- Type casting-Operators and control statements -Input and output statements - Function Prototyping-Inline function- Overloaded function-Introduction to friend function. **(9)**

CLASSES AND OBJECTS

Class specification- Member function definition- Nested member function-Access qualifiers-Static data members and member functions -Instance creation-Array of objects-Dynamic objects-Static Objects-Objects as arguments- Returning objects.

Constructors -Parameterized constructors- Overloaded Constructors- Constructors with default arguments -Copy constructors- Dynamic constructors- Dynamic initialization using constructors-Destructors. **(9)**

OPERATOR OVERLOADING

Operator function-Overloading unary and binary operator-Overloading the operator using friend function-Stream operator overloading-Data Conversion. **(9)**

INHERITANCE

Defining Derived classes-Single Inheritance-Protected Data with private inheritance- Multiple Inheritance-Multilevel inheritance-Hierarchical Inheritance-Hybrid Inheritance -Multipath inheritance-Constructors in derived and base class-Template in inheritance- Abstract classes-Virtual function and dynamic polymorphism-Virtual Destructor-Nested Classes. **(9)**

I/O STREAMS

I/O STREAMS - unformatted I/O operations - formatted I/O operations - manipulators - hierarchy of file stream classes - opening and closing of files - file pointers and manipulation - sequential access file - random access file. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXTBOOKS

1. Robert Lafore, "Object Oriented Programming in Turbo C++", 4th Edition, Galgotia Publications Pvt. Ltd., New Delhi, 2001.
2. Budd Timothy, "Introduction to Object-Oriented Programming", 3/E,Pearson Education India, 2008.

REFERENCE BOOKS

1. HerbertSchildt,"C++:TheCompleteReference",TataMcGrawHillPublishingCompany,NewDelhi,2003.
2. K.R.Venugopal,RajkumarandRavishankarT,"MasteringC++",TataMcGrawHillPublishingCompany, 2011.
3. Deitel, "C++ How to Program", Prentice Hall of India, New Delhi, 2004.
4. Bruce Eckel, "Thinking in C++", II Edition, PEA, 1999.
5. BjarneStroustrup, "The C++ Programming Language", 3rd Edition, Pearson Education Asia, 2001.
6. Art Friedman, Lars Klander and Mark Michaelis, "C/C++ Annotated Archives", Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1999.

TUTORIALS

1. Basic Programs implementing Constructors, Destructors
2. Operator Overloading
3. Function Overloading
4. Inheritance
5. Multiple and Multi-level, Access Specifiers
6. Function Overriding
7. Pure Virtual Functions
8. Abstract Classes
9. I/O Streams
10. File Handling

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X				X						
CO2		X	X			X				X	X	
CO3			X	X	X	X				X	X	
CO4						X		X	X	X	X	

13EE47 - SYNCHRONOUS AND INDUCTION MACHINES LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To conduct load test and predetermination test on Induction Motor and Alternator and hence to check the performance of various types of AC machines.

COURSE OUTCOMES

CO1 : *The learners after completion of the laboratory will be able to find the performance of AC machines of any rating.*

CO2 : *The students can test synchronous and induction machines.*

CO3 : *The students can incorporate microgrid with the knowledge of synchronization of alternators to busbar and voltage regulation of alternators.*

LIST OF EXPERIMENTS

1. Performance characteristics of three phase squirrel - cage induction motor by direct load test.
2. Performance characteristics of three phase slip - ring induction motor by direct load test.
3. Predetermination of performance characteristics of three phase squirrel cage induction motor by equivalent circuit and circle diagram methods.
4. Separation of No-load losses of Three Phase Induction Motor.
5. Performance characteristics of single phase induction motor by direct load test.
6. Predetermination of performance characteristics of single phase induction motor by equivalent circuit method.
7. Predetermination of voltage regulation of three phase alternator by EMF and MMF methods.
8. Predetermination of voltage regulation of three phase alternator by Potier triangle method.
9. Predetermination of voltage regulation of three phase salient pole alternator by slip test.
10. Determination of V and inverted V curves of three phase synchronous motor.
11. Load test on cascaded induction motors.
12. Load test on induction generators.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)												
COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X	X	X	X	X				X	
CO2	X					X	X				X	
CO3	X				X	X	X	X	X	X	X	

13EE48 - DIGITAL INTEGRATED CIRCUITS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To develop students, pertaining the skill of designing any digital electronic circuits with digital IC's.

COURSE OUTCOMES

CO1 : *The learners will have real time design and testing experience of combinational circuits and sequential circuits using digital IC's for the given requirements.*

CO2 : *The students can design finite state machines*

CO3 : *The students can invent new products by developing mini projects.*

LIST OF EXPERIMENTS

1. Interfacing TTL and CMOS Circuits.
2. Adders and Subtractors, Serial adder and Parallel adder.
3. Design of Magnitude Comparator and study of ALU.
4. Design of Combinational Circuits.
5. Design of Finite State Machine for sequence generation / sequence detection.
6. Multiplexer, Demultiplexer, Encoder and Decoder.
7. Design of Synchronous and Asynchronous Counters.
8. Shift Registers and PRBS Generators.
9. Design of Code converters.
10. BCD to seven segment Display.
11. Design of frequency counter.
12. Design of digital clock.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X	X	X	X	X			X	X	
CO2		X		X		X	X			X	X	
CO3						X	X	X	X	X	X	

13EE51 - DESIGN OF ELECTRICAL MACHINES

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart knowledge on the Selection of magnetic, conducting and insulating materials and to provide knowledge on the design aspects of electrical Machines and to introduce computer aided machine design.

COURSE OUTCOMES

CO1 *: The students will acquire knowledge of design of rotating electrical Machines and Transformers.*

CO2 *: The students will be able to design the Magnetic and Electrical circuits of Electrical Machines.*

CO3 *: The students will acquire knowledge about the various Magnetic and Insulating materials used in Electrical Machines.*

INTRODUCTION

Design factors - Limitation in design - Various Conducting materials, Insulating materials and Magnetic materials. Design of Magnetic Circuits :MMF calculation for Air gap and Teeth - Iron losses and Magnetizing current calculations. Design of Armature Windings: Types of Winding for AC and DC Machines. **(9)**

D.C. MACHINES

Output equation - Choice of Specific loadings-Choice of poles and speed- Main Dimensions - Length of Air gap - Design of Armature -Design of Field System- Commutator and Brush Design. **(9)**

SYNCHRONOUS MACHINES

Choice of Electric and Magnetic loadings - Main dimensions -Length of Air gap - Short circuit ratio - Stator core design and Rotor core Design for salient pole and turbo alternators - Design of Pole and Field winding - design of damper windings. **(9)**

THREE PHASE INDUCTION MOTORS

Output equation - Choice of Electric and Magnetic loadings - Main dimensions - Stator core design - Length of Air gap - Rotor core Design - No load current calculation-Stator and Rotor Resistance calculations- Introduction to Energy Efficient Motors.

Single phase induction motor: main dimensions -design of stator - rotor design. **(9)**

TRANSFORMERS

Output equation - Design of core - Optimum Design for weight, volume, cost and losses - Overall Dimensions -design of Windings - No load current and losses calculations-temperature rise and regulation from design data- Design of Tank and Cooling tubes-design of inductors. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. A.K. Sawhney, "A course in Electrical Machine Design", Dhanpat Rai & Sons, Reprint 2010.
2. K.G.Upadhaya, "Design of Electrical Machines", New Age International, Ist Edition, 2008.

REFERENCE BOOKS

1. R.K.Agarwal, Electrical Machine Design - S.Kataria& Sons, N.Delhi. 4th Edition, Reprint, 2003.
2. S.K.Sen, Principles of Electricsl machine Design - Oxford & IBH pub. Co. Pvt. Ltd., 2nd Edition, 2001.
3. M.V. Deshpande, "Design and Testing of Electrical Machines",PHI Learning Private Limited, Delhi, 2013.
4. K.G.Upadhaya, "Design of Electrical Machines", New Age International, Ist Edition, 2001.
5. V.N. Mittle,"Design of Electrical Machines, Standard Publishers Distributors,2005.
6. Juha Pyrhones, Tapans Jokines," Design of Rotating Electrical Machines", John Wiley and Sons,2009.

TUTORIALS

1. DC Machines: D & L Calculations, no of armature slots, conductor dimension, shunt and series field
2. Synchronous Machines: Main dimension calculation, length of air gap, number of stator slots, salient pole and nonsalient pole rotor design, damper winding design.
3. Induction Machines: D & L Calculations, number of stator slots, number of rotor slots, no load current calculation.
4. Transformers: Over all dimensions Calculations, window design, winding design, no load current calculation. Calculations of number of cooling tubes.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X			X	X						
CO2			X	X	X				X		X	
CO3		X				X	X	X	X	X	X	

13EE52 - POWER SYSTEM ANALYSIS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To learn the power system modeling and algorithms for the analysis of electrical power systems. To know the recent developments in power flow analysis. To study the dynamics of operation and control of power systems under normal and abnormal conditions.

COURSE OUTCOMES

CO1 : *The students would have learnt about power system components.*

CO2 : *They will be able to solve the load flow problems using efficient numerical methods.*

CO3 : *They will be able to analyze the power system transients and faults and select the rating for protective devices.*

CO4 : *They will be able to study the dynamics of power systems and know about the task of maintaining a reliable electric power system.*

REPRESENTATION OF POWER SYSTEM COMPONENTS

Single line diagram - per unit quantities - per unit impedance / reactance diagrams - Complex Power - Representation of Loads - π equivalent circuit of transformer with off nominal tap ratio - Bus admittance matrix - Formulation of Y_{bus} - Formation of Z_{bus} using step-by-step building algorithm. **(9)**

LOAD FLOW STUDIES

Load flow equations and methods of solutions - Gauss-Seidel method for load flow studies - Newton-Raphson method for load flow studies - Introduction to Bus Voltage Control Methods using STATCOM and UPFC Devices-FDLF method. **(9)**

FAULT CALCULATIONS

Balanced and unbalanced faults - Types of faults - Symmetrical faults - Consideration of prefault load current - Symmetrical components - Sequence impedances and sequence networks for synchronous machines, transmission lines, transformers - formation of sequence networks - Unsymmetrical fault analysis - single line to ground fault, line to line fault, double line to ground fault. **(9)**

POWER SYSTEM TRANSIENTS

Travelling waves on transmission lines - Wave equations - Surge impedance - Equivalent circuit for travelling wave studies - Reflection - Refraction - Forked line - Arcing grounds - Switching Transients - Capacitance switching. **(9)**

POWER SYSTEM STABILITY

Steady state and transient state stability of power systems - Stability limits - Swing equation for single machine infinite bus system - Solution of swing equation by equal area criterion - Methods of improving transient stability - Automatic Voltage Regulators-Load Frequency Control. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOK

1. D.P. Kothari, I.J.Nagrath, "Modern Power System Analysis", Tata McGraw Hill, 2011.

REFERENCE BOOKS

1. C.L.Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2010.
2. John J. Grainger, W.D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill, 2007.
3. B.R.Gupta, "Power System Analysis and Design", IIIrd Edition, Wheeler Publishers, 2003.
4. Hadi Saadat, "Power System Analysis", Tata McGraw Hill, IIIrd Edition, reprint, 2004.
5. B.M. Weedy, "Electric Power Systems", John Wiley, New York, 1987.
6. T.K. Nagsarkar, M.S. Sukhija, “Power System Analysis”, Oxford University Press, 2007.

TUTORIALS

1. Studyof IEEE Bus Systems.
2. Formulation of Y_{bus}
3. Formation of Z_{bus}
4. Load Flow studies using Gauss Seidel Method.
5. Load Flow studies using Newton Raphson Method.
6. Measurement of balanced and unbalanced power in a three phase systems.
7. Fault Analysis.
8. Design of Capacitor banks.
9. Swing equation
10. Rotor angle Stability analysis.
11. Modeling and Simulation of AVRs
12. Modeling of any one of the FACTS devices.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X									
CO2	X	X	X	X	X	X	X					
CO3	X	X	X	X	X	X	X	X				
CO4	X	X	X	X	X	X	X	X	X	X		

13EE53 - CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the basic concepts of physical systems and modeling. To impart in-depth analysis of system dynamics in time-domain and frequency domain using classical techniques and state-space models.

COURSE OUTCOMES

At the end of the course the learner will be able to

CO1 : *Model all types of physical systems.*

CO2 : *Analyze systems in time domain and in frequency domain.*

CO3 : *Design compensators in time domain and frequency.*

INTRODUCTION

Concept of control system - physical system - linear systems and their properties - transfer function - mathematical modeling of electrical and mechanical systems - analogous systems - open loop and closed loop systems -effect of feedback on system sensitivity - block diagram representation - block diagram algebra - signal flow graphs and their properties - Mason's gain formula.

Control system components: potentiometer, tacho-generator, synchros, AC and DC servomotors, gear trains. **(12)**

TIME RESPONSE ANALYSIS

Standard test signals - time domain study of first order and second order feedback control systems - time domain specifications - response with P, PI, PD, and PID controllers - steady state error - static error constants - dynamic error coefficients. **(9)**

FREQUENCY RESPONSE ANALYSIS

Frequency response specifications - estimation for second order systems - correlation between time domain and frequency domain specifications - Bode plot - Polar plot. **(8)**

CONCEPT OF STABILITY AND ROOT LOCUS

Definitions of stability - location of roots on the s-plane for stability - Routh Hurwitz criterion - Nyquist stability criterion - relative stability - gain margin and phase margin.

Root locus: concepts of root-locus - construction of root locus - determination of open loop gain for a specified damping of the dominant roots. **(9)**

LINEAR SYSTEM DESIGN

Design problem - Preliminary consideration of classical design - Realization of lag, lead and lag-lead compensators - Frequency domain design of lag and lead compensators. **(7)**

TOTAL : 45

TEXT BOOKS

1. J. Nagrath and M.Gopal, "Control Systems Engineering", VIth Edition, New Age International Publishers, New Delhi, 2011.
2. Katsuhiko Ogata, "Modern Control Engineering", IVth Edition, Prentice Hall of India Private Ltd., New Delhi, 2008.

REFERENCE BOOKS

1. M.Gopal, "Control Systems - Principles and Design", 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Benjamin C. Kuo "Automatic Control Systems", 8th Edition, Prentice Hall of India, New Delhi, 2009.
3. Norman S. Nise, "Control Systems Engineering", 4th Edition, John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2004.
4. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", 10th Edition, Pearson Prentice Hall, NJ, 2008.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X		X	X						
CO2		X	X			X	X	X	X	X	X	
CO3				X			X	X	X	X	X	

13EE54 - DATA STRUCTURES AND ALGORITHMS

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the different data structures. To design an algorithm and/or to select algorithms to solve the given problem. To model the given problem through graphs and find an optimal solution for the same through performance analysis of algorithms designed.

COURSE OUTCOMES

At the end of the course students will

CO1 : *Have a knowledge of the fundamental data structures used in computer science.*

CO2 : *Learn the importance of modeling through graphs and trees and their applications*

CO3 : *Know how to analyze the space and time efficiency of commonly used algorithms.*

CO4 : *Be able to design new algorithms or modify existing ones for new applications and reason about the efficiency of the result.*

BASIC DATA STRUCTURES

Arrays- Array of structures - Polynomial representation - Multidimensional Arrays - Sparse Matrices - Transpose and Multiplication of Sparse Matrices - Stacks and Queues: Implementation and Applications. **(9)**

ADVANCED DATA STRUCTURES

Trees: Binary Tree - Tree Traversals - Binary Search Trees - AVL Trees - Splay Trees - B Trees - Red Black Trees. **(9)**

GRAPHS ALGORITHMS

Elementary Graph Algorithms - Minimum Spanning Trees - Topological Sorting - Single-source Shortest Paths - All Pairs Shortest Paths. **(9)**

SORTING AND HASHING

Insertion Sort - Shell Sort - Heap Sort - Merge Sort - Quick Sort - Radix Sort - External Sort - Analysis of Sorting Algorithms - Hashing :- Hash Functions - Separate Chaining - Open Addressing - Rehashing - Extendible Hashing. **(9)**

ALGORITHM DESIGN TECHNIQUES (QUALITATIVE TREATMENT ONLY)

The role of Algorithms in computing - Growth of functions. Introduction to algorithms design: Divide and Conquer - Dynamic Programming - Greedy Algorithm - Backtracking - Branch and Bound - Randomized Algorithms - Introduction to NP Problems. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. M A Weiss, "Data Structures and Algorithm Analysis in C++", 3rd Edition, Pearson Education, 2009.
2. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, "Introduction to Algorithms", 2nd Edition, Prentice Hall of India, 2002.

REFERENCE BOOKS

1. R G Dromey, "How to Solve it by Computers", Pearson Education Asia, 2005.
2. Robert L Kruse, Clovis LTando and Bruce P Leung, "Data Structures and Program Design in C", 2nd Edition, Prentice Hall of India. 1996.
3. Jean Paul Trembley, Paul G Sorenson, "An Introduction to Data Structures with Applications", 2nd Edition, Tata McGraw Hill, 2007.

TUTORIALS

1. Arrays
2. Array of Structuress
3. Linked List
4. Trees
5. Graphs
6. Linear Sorting Algorithms
7. Heap Sorting
8. Searching
9. Shortest Path Algorithm
10. Divide and Conquer Algorithm
11. Branch and Bound Algorithm

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X									
CO2	X	X	X	X	X	X	X					
CO3	X	X	X	X	X	X	X	X				
CO4	X	X	X	X	X	X	X	X		X		

13EE55 - COMPUTER ARCHITECTURE AND ORGANISATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the students the concepts of computer architecture. To make the students to write assembly language program. To learn the parallel processing concepts and Pentium processor architecture.

COURSE OUTCOMES

CO1 : *The students can design and implement microprocessor based system for various control and other applications.*

CO2 : *The students can understand the various architectures available for microprocessor ALU, control unit, memory and input output organization.*

CO3 : *The students can understand the concepts related with pipeline and parallel processing and algorithm used in implementation.*

CPU DESIGN

Introduction - Design and implementation of simple CPUs : Fetching, decoding and executing of instructions, designing the control unit using hardwired control - short comings of simple CPUs - Real world examples Internal architecture of 8085 microprocessor. **(9)**

MICROSEQUENCER CONTROL UNIT DESIGN

Design and implementation Basic micro sequencer : basic layout, generating micro sequence and designing the mapping logic - Microsubroutines - Microcode Jumps - Micro programmed control Vs hardwired control complexity of instruction set, ease of modification, clock speed - real world example : micro coded CPU: Pentium processor. **(9)**

COMPUTER ARITHMETIC AND MEMORY ORGANIZATION

Unsigned and signed notation - Specialized arithmetic hardware - floating point numbers - Real world examples : the IEEE 754 floating point standard - Hierarchical memory systems - cache memory - Virtual memory - Real world examples :Memory management in a Pentium based personal computer. **(9)**

INPUT/OUTPUT ORGANIZATION

Asynchronous data transfer - programmed input/output - interrupts - direct memory access - input/output processors - serial communication - Real world examples : serial communication standards, RS 232 standards, RS 422 standards, universal serial bus standards. **(9)**

REDUCED INSTRUCTION SET COMPUTING AND PARALLEL PROCESSING

RISC vs CISC - RISC : Addressing modes, instruction sets, instruction pipelines and its conflicts - register windows - Parallelism in uniprocessor systems - organization of multi processor systems ; flynn's classification, MMID systems architecture - communication in multiprocessor systems - Parallel Algorithms:- Bubble Sort - Matrix Multiplication. **(9)**

TOTAL : 45

TEXT BOOKS

1. Carpinelli, "Computer Systems Organization and Architecture", Pearson Education India, 2008
2. David A. Peterson, John L. Hennessy, "Computer Organization & Design: The Hardware/Software Interface", Morgan Kaufmann Publishers, 2013.

REFERENCE BOOKS

1. John L. Hennessy, David A. Patterson, Andrea C. Arpaci-Dusseau,Remzi H. Arpaci-Dusseau, Asanovi, "Computer Architecture: A Quantitative approach", Morgan Kaufmann Publishers, 2006
2. Andrew S. Tanenbaum, "Structured Computer Organization",Prentice Hall, 2012.
3. William Stallings, "Computer Organization and Architecture: Designing for Performance",Prentice Hall, 2002.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X			X	X	X	X		X	
CO2	X			X		X	X					
CO3	X		X	X	X					X		

13EE56 - MICROCONTROLLER BASED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To expose the students to the fundamentals of microcontroller architecture and programming. To inhibit knowledge in developing control circuits for real time application. To make the students understand the interfacing circuitry with the microcontroller.

COURSE OUTCOMES

With knowledge about microcontrollers the students can

CO1 : *Write assembly language programs for performing different computing functions.*

CO2 : *Interface various I/O devices with PIC microcontroller.*

CO3 : *Design, develop and control a system using either a 8 bit microcontroller or an ARM microcontroller.*

PIC ARCHITECTURE

PIC Architecture- RISC Architecture-PIC18F458 Pin connection-PIC 18 Configuration registers-PIC 18 Trainer Design and Loading-WREG register in PIC-PIC File Register-PIC Status register-PIC Data format and Directives. **(9)**

PIC PROGRAMMING

Introduction to PIC Assembly language programming -Assembling and Linking a PIC program-Program ROM Space in PIC, viewing register and memory with Simulator-Branch Instructions and Looping-Call instructions and stack-PIC 18 time delay and Instruction Pipelining-I/O Port programming-I/O Bit manipulation programming-AL Instructions-Timer programming-programming timers 0 and 1-counter programming. **(9)**

ARM ARCHITECTURE

An Introduction to Processor Design-Instruction set design-Processor design trade offs-RISC-ARM architecture-Architectural inheritance-ARM programmer's model-ARM development tools-ARM Organization and Implementation-3-stage pipeline ARM organization-ARM instruction execution-ARM implementation-ARM coprocessor interface. **(9)**

ARM PROGRAMMING

ARM Assembly Language Programming- Data processing instructions-Data transfer instructions-Control flow instructions-ARM Instruction set-Conditional execution-Branch and Branch with link-Data processing instructions-multiply instructions-multiple register transfer instructions **(9)**

SYSTEM DESIGN

Interfacing LCD Display - Keypad Interfacing - Stepper Motor interfacing- Motor Control - Controlling AC appliances -Measurement of frequency -Stand-alone Data Acquisition System **(9)**

TOTAL : 45

TEXT BOOKS

1. Steve Furber,"ARM System-on-Chip Architecture" Pearson Education Limited, 2012.
2. Muhammad Ali Mazidi,"PIC Microcontroller and Embedded Systems" 1st edition, Pearson Education, 2008.

REFERENCE BOOKS

1. John Iovine, 'PIC Microcontroller Project Book ', McGraw Hill 2000.
2. John. B. Peatman, "Design with PIC Microcontroller", Pearson Education, 2003.
3. ARM Architecture, Reference Manual, ARM Ltd.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X		X	X	X						
CO2	X	X		X	X		X	X				
CO3		X		X	X		X	X	X	X	X	

13EE57 - CONTROL SYSTEMS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

Learn to simulate dynamic systems in the Matlab environment, familiarize the student with theoretical and practical aspects of making physical measurements,familiarize students with the behavior of control systems and enable them to understand the role the system parameters in control system response.

COURSE OUTCOMES

The students can:

CO1 : *analyze the Transient & Steady State Performance of a system.*

CO2 : *analyze the stability of an Electrical, Electronics and other physical systems.*

CO3 : *design experiments to measure system parameters.*

CO4 : *design the control system which is required in the process.*

CO5 : *Implement, test and evaluate various control algorithms.*

LIST OF EXPERIMENTS

1. Transfer Function of DC Motor.
2. Transfer Function of 2 phase AC Servo Motor.
3. Frequency Response plots.
4. Time Response plots.
5. Simulation of Transfer Function using OPAMP.
6. DC/AC Servo Motor Position control system.
7. Process control simulator.
8. Stepper Motor control system.
9. Design of Compensators.
10. Magnetic Levitation system.
11. Study of PID controller.
12. Study of Synchro Devices.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)												
COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X		X			X	X			
CO2	X	X	X	X	X	X						
CO3	X	X	X			X	X	X	X	X	X	
CO4	X	X	X	X	X	X		X	X	X		
CO5	X	X	X	X	X		X	X	X	X		

13EE58 - MICROCONTROLLERS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To provide practical experience with microcontroller systems. To encourage cooperative team work and develop communication skills.

COURSE OUTCOMES

CO1 : *Students should be able to solve basic binary math operations using the microcontroller.*

CO2 : *Students should be able to demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microcontroller.*

CO3 : *Students should be able to apply knowledge of the microcontroller internal registers and operations by use of a PC based microcontroller simulator.*

CO4 : *Students should be able to write assembly language programs, assemble into machine a cross assembler utility and download and run their program on the training boards.*

CO5 : *Students should be able to design electrical circuitry to the microcontroller I/O ports in order to interface the processor to external devices.*

CO6 : *Students should be able to write assembly language programs and download the machine code that will provide solutions to real-world control problems.*

LIST OF EXPERIMENTS

1. Programming using a microcontroller to perform arithmetic operations.
2. Programming using a microcontroller to find square and square root of a number.
3. Programming using a microcontroller to perform arithmetic operations on multibyte numbers.
4. Programming using a microcontroller to perform code conversions.
5. Programming using a microcontroller to perform array addition and subtraction.
6. DC Motor Interface using a microcontroller.
7. Stepper Motor Interface using a microcontroller.
8. Traffic Light Controller Interface using a microcontroller.
9. LED interfacing using a microcontroller.
10. Seven segment display Interface using a microcontroller.
11. Temperature sensing using PIC 16F877A and display.
12. Fault current indication using PIC 16F877A (Buzzer)

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X	X	X	X		X	X	
CO2	X	X	X	X	X	X	X	X		X	X	
CO3		X	X	X	X	X	X	X	X	X	X	
CO4		X	X	X	X	X	X	X	X	X	X	
CO5		X	X	X	X	X	X	X	X	X	X	
CO6		X	X	X	X	X	X	X	X	X	X	X

13EE61 - POWER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To enable the students to understand the problems faced by modern power industries and how power electronics can overcome these problems. To introduce to the students the different modern power semiconductor devices, various topologies and operation of power electronic circuits such as ac to dc, dc to dc, ac to ac and dc to ac converters.

COURSE OUTCOMES

At the end of the course the students will be able to:

CO1 : *Realize the characteristics of important power semiconductor devices and converters to model and simulate them.*

CO2 : *Analyze the steady-state operation of power electronic converters and to understand the basic requirements of industrial power electronics.*

CO3 : *Work in teams and independently for the design, development and testing of power electronics systems.*

POWER SEMICONDUCTOR DEVICES

Introduction - Need for power conversion - Generic Power Converter- Power Semiconductor Switches - Idealized Characteristics-Power diodes -Thyristor family of devices: SCR-TRIAC-GTO-IGCT- Transistor family of devices: Power MOSFETs - IGBTs - comparison of power semiconductor switches - steady state and dynamic characteristics - switching and conduction losses- Intelligent Power Modules- protection circuits-heat sink calculations. **(9)**

AC-DC CONVERTERS

Introduction - phase angle control - single phase and three phase semi bridge and full bridge converters - dual converters - quadrants of operation-estimation of performance parameters for continuous current operation - effects of load and source inductances - development of control circuit--synchronization and isolation - introduction to active front converter- device selection. **(9)**

DC-DC CONVERTERS

Principle of chopper operation - control strategies - isolated and non-isolated choppers- step down chopper - step up chopper-step down-up chopper- quadrants of operation.

Switched mode regulators - buck regulator - boost regulator - buck-boost regulator - cuk regulator - comparison of regulators - control circuit -device selection for dc-dc converters- introduction to resonant power converters. **(9)**

AC-AC CONVERTERS

AC voltage Controllers - principle of ON-OFF control and phase angle control- single phase and three phase voltage controllers - Estimation of performance parameters- single phase transformer connection changers.

Cycloconverters-basic principle of operation-single phase and three phase cyclo converters - output voltage equation - device selection for ac-ac converters- introduction to matrix converter. **(9)**

DC-AC CONVERTERS

Principle of operation - single phase series inverter - parallel inverter - bridge type inverters-voltage source inverters and current source inverters- single phase and three phase bridge configurations-estimation of performance parameters-voltage control of inverters- harmonic reduction -device selection-introduction to multi level inverters.

Applications: UPS - SMPS - HF induction heating -electronic lamp ballast. **(9)**

TOTAL : 45

TEXT BOOKS

1. M.H.Rashid, "Power Electronics: Circuits, Devices and Applications", IV Edition, Pearson Education Asia, New Delhi 2012.
2. Ned Mohan, M.Undeland and William P.Robinson, "Power Electronics - Converters, Applications and Design", III Edition, Wiley India, New Delhi, 2012.

REFERENCE BOOKS

1. M.D.Singh and K.B. Khanchandani, "Power Electronics", IInd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2011.
2. Joseph Vithayathil, "Power Electronics Principles and Applications", Tata McGraw-Hill Education, New Delhi, 2011.
3. G.K.Dubey., etal,"Thyristorised Power Controllers" New Age Publishers, II edition, Chennai, 2010.
4. L.Umanand, "Power Electronics: Essentials & Applications" Wiley India Pvt. Limited. New Delhi, 2009.
5. John.G.Kassakian,et.al, "Principles of Power Electronics" Pearson Education Asia, New Delhi, 2010.
6. http://nptel.ac.in/courses/108101038/ for Video Type.
7. http://nptel.ac.in/courses/webcourse - contents / IIT% 20 Kharagpur / Power%20 Electronics/ New_index1.html for Web type.
8. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X						X				
CO2	X	X		X				X				
CO3	X	X	X	X			X	X			X	

13EE62 - POWER SYSTEM PROTECTION

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To offer a detailed understanding of the types of relays, circuit breakers and other protective devices used in power system.

COURSE OUTCOMES

At the end of the course the students will be able to:

CO1 : *Identify and implement the suitable protective schemes for all types of faults*

CO2 : *Learn the working principles of circuit breakers, fuses and its selection*

CO3 : *Utilize the theoretical background for practical implementation of the protection of power system components.*

CO4 : *Realize the causes of over voltages, transient currents in power system*

CO5 : *Design and develop microcontroller based protective relays.*

PROTECTIVE RELAYS

Basic requirements of protective relays -Nature and causes of faults- Types of faults- Fault statistics- Functional characteristics of relay- relay terms- Classification of relays -Electromagnetic Relays- Non-directional and directional over current relays -Distance relays - Differential relays-Earth fault and phase fault relays - Universal torque equation. **(9)**

CIRCUIT BREAKERS

Elementary principle of arc extinction - re-striking, rate of rise of re-striking and recovery voltages - Arc-interruption theories-Bulk oil - minimum oil - air blast - vacuum - SF6 circuit breakers - Industrial circuit breakers: MCCB- ELCB- Rating, Selection and Testing of circuit breakers. **(9)**

APPARATUS PROTECTION

Protection of transformers -Protection of generators - Protection of motors-- Bus zone protection- Protection of transmission lines - CTs and PTs and their applications in protection schemes- Fuses -Fuse Characteristics- Selection of Fuses- HRC fuses. **(9)**

PROTECTION AGAINST OVERVOLTAGES

Voltage surge - Causes of over voltages - Switching, Insulation failure, Arcing grounds and Resonance - Lightning Phenomena - Protection of transmission lines, stations and substations against lightning- Methods of protection - Surge diverter -Types - Surge absorber - Groundings - Methods of Neutral grounding - Basic ideas of insulation coordination. **(9)**

STATIC RELAYS

Basic elements of a static relay- Amplitude, phase and hybrid comparator schemes - block diagram representation of static relays: Static over current relay- Static directional relay-Static differential protection- Static Distance relay.

Microcontroller based relays - Block diagram representation of over current and impedance relays- Introduction to digital protection. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. Badri Ram and D.N.Vishwakarma, "Power System Protection and Switchgear", Tata McGraw Hill publishing company Ltd., New Delhi, 2011.
2. C.L.Wadhwa, "Electrical Power Systems", VI Edition, New Age International Pvt. Ltd., 2011.

REFERENCE BOOKS

1. B.Ravindranath and M.Chander, "Power System Protection and Switchgear", New Age International Pvt. Ltd., New Delhi, 2011.
2. T.S. Madhavarao, "Power System Protection - Static Relays", Tata McGraw Hill, 1989.
3. Sunil S. Rao, "Switch Gear and Protection", Khanna Publishers, 2004.
4. M.L.Soni, P.V.Gupta and U.S.Bhatnagar, "A Course in Electrical Power", Dhanpat Rai and Sons, 2003.
5. Bhavesh Bhalja, R.P. Maheswari, Nilesh G. Chothani, “Protection and Switch Gear”, Oxford University Press, 2011.

TUTORIALS :

1. Choice of suitable relay using IDMT characteristics.
2. Design of relay settings for the given specifications.
3. Design of Merz price protection.
4. Design of pilot relays for the protection of transmission lines.
5. Determination of restriking voltage, RRRV and Average RRRV.
6. Finding suitable earthing resistance for alternator protection.
7. Demonstration of Circuit Breaker operation in a transmission line.
8. Choice of suitable circuit breaker for a power station.
9. Design of ground resistance for the protection of electrical apparatus.
10. Design of ground resistance for the protection of power station.
11. Design of lightning arresters for the protection of buildings against lightning.
12. Micro controller based IDMT / DMT type over current relay study trainer.
13. Cable fault locator study trainer.
14. Relay control system.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				X	X					X	X	
CO2		X	X			X	X					
CO3			X	X		X	X	X	X	X	X	
CO4				X		X	X	X	X	X	X	
CO5						X	X	X	X	X	X	

13EE63 - GENERATION OF ELECTRICAL ENERGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To know the types of load and review the various conventional electricity generation methods. To understand the various distributed generation resources and technologies expected to play a key role in region's energy future.

COURSE OUTCOMES

At the end of the course the students will be able to:

CO1 : *Learn the load pattern and its impact on energy demand.*

CO2 : *Understand the sources of power generation.*

CO3 : *Understand the concepts and technologies of a significant new paradigm for the generation, use and delivery of sustainable electric power.*

CO4 : *Evaluate and plan power generation to meet the demands of a state and determine the adequacy of power generation to meet the specified demand.*

LOAD ANALYSIS

Demand For Electric Power - Load Curves And Load Curve Analysis - Reliability Evaluation - Outages, Cause and Interruptions - Cost Versus Reliability - Short and Long - Range Planning - load demand - diversity and plant factors - Decision-Making Philosophies - Cost and Economic Evaluation -Daily/Monthly generation simulations and its comparison to a building consumption. **(9)**

CONVENTIONAL GENERATION

Hydroelectric power plants - large, medium and small head plants - Choice of turbines - Plant lay out - pumped storage plants- Steam plants - layout - Diesel and gas turbine stations - nuclear power plants - Safety Aspects - Environment Concern. **(9)**

INTRODUCTION TO DISTRIBUTED POWER GENERATION

Distributed Generation Versus Traditional Power Systems : Introduction - Distributed versus Central Station Generation - Mini Gas Turbine Generators - Micro Gas Turbine Generators- Microhydel Plant - Biomass Power - Fuel Cell Powered Distributed Generators : Proton Exchange Membrane Fuel Cells - Phosphoric Acid Fuel Cells - Molten Carbonate Fuel Cells - Solid Oxide Fuel Cells - Hydrogen Fuel Cells - Ultracapacitors based energy storage systems - Flywheel - Electric Vehicles **(9)**

SOLAR PV SYSTEMS

Solar radiation and measurement - solar cells and their characterization - influence of insulation and temperature-Block diagram of solar photo voltaic system- Solar PV Cell- Characteristics and Types - Arrays and Panels - Balance of Systems - DC power conditioners - Maximum power point tracking algorithms - AC power conditioners - line commutated thyristor inverters - Synchronized operation with grid supply - stand-alone inverters. Solar PV Applications - Water pumping, refrigeration, street lighting, audio-visual equipments - economic analysis of PV systems **(9)**

WIND ENERGY SYSTEMS

Basic principle of wind energy conversion - nature of wind - power in the wind - Site selection considerations - components of Wind Energy Conversion System (WECS) - Classification of WECS - Generating Systems - Schemes of electrical generation - generator control - load control - Energy storage - Hybrid Renewable Energy Systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. R.K.Rajput, " A Textbook on Power Systems Engineering", Laxmi Publications, New Delhi, 2006
2. M.N.Bandyopadhyay, " Electric Power Systems: Theory and Practice", Prentice Hall of India, New Delhi, 2006.
3. Mukund R. Patel, "Wind and Solar Power Systems" CRC Press, New York, 2009

REFERENCE BOOKS

1. P Breeze, “Power Generation Technologies”, 2nd Edition, Elsevier, 2014.
2. Digambar M. Tagare, "Electricity Power Generation: The Changing Dimensions, John Wiley & Sons, 2011
3. C.L.Wadhwa, "Electrical Power Systems", New Age International, 2007.
4. Joshua Earnest, Tore Wizelius, "Wind Power Plants and Project Development" PHI Learning Private Limited, New Delhi, 2011.
5. Adolf Goetzberger, Volker Hoffmann "Photovoltaic Solar Energy Generation" Springer-Verlag Berlin Heidelberg 2005
6. Roger Messenger, Jerry Venture, "Photovoltaic Systems Engineering" CRC Press, New York, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X	X	X	X	X	X		
CO2	X		X	X				X	X	X		
CO3	X	X	X	X	X	X	X	X	X	X		
CO4	X	X	X	X	X	X	X	X	X	X		

13EE64 - DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart the students fundamental concepts of digital signal processing and algorithms. To design and realize digital filters using different methodologies. To familiarize the architecture of digital signal processors.

COURSE OUTCOMES

At the end of the course the students will be able to:

CO1 : *Solve problems in signal processing, design and realize digital filters theoretically and in digital signal processors.*

CO2 : *To analyse signals and systems.*

CO3 : *Design DSP based controllers for electrical applications such as speed control of motor.*

DISCRETE TIME SIGNALS AND SYSTEMS

Discrete time signals - classification - sampling - aliasing - discrete time systems - classification - linearity - time invariance - causality - stability - convolution - correlation - analysis of discrete time systems **(7)**

FOURIER ANALYSIS OF DISCRETE TIME SIGNALS

Discrete Fourier Transform (DFT) - Properties - IDFT - Discrete-Time Linear System Analysis by DFT - Fast Fourier Transform (FFT) - Properties - Radix-2 Decimation in Time FFT - Radix-2 Decimation in Frequency FFT - IDFT. **(9)**

FILTERS

Types - Butterworth filters - Chebyshev filters - Z- Transform - ROC - IIR filter design by Impulse Invariance Method - Bilinear Transformation Method - Design of FIR filters by frequency sampling - FIR filters using windowing functions : Rectangular, Triangular, Hanning, Hamming, Kaiser. **(11)**

IMPLEMENTATION OF DISCRETE TIME SYSTEMS

Realization of IIR filters - direct form realization - cascaded form - parallel form - realization of FIR filters - transversal structure - linear phase realization - poly phase realization - quantization noise -quantization errors - quantization errors in computation of DFT and FFT algorithms. **(9)**

DIGITAL SIGNAL PROCESSOR AND APPLICATIONS

Digital Motor Control Drivers - Requirements - Architecture of DSP Controller -Peripherals - PWM Generator - Applications of DSP in Electrical Appliances, Motor Control, Power Supply Inverters, Robotics and Automotive Control. **(9)**

TOTAL : 45

TEXT BOOKS

1. Richard G.Lyons, " Understanding Digital Signal Processing", III edition, Prentice Hall, 2012
2. Ashok Ambardar, "Analog and Digital Signal Processing", II Edition, Thomson Asia Pvt. Ltd., Singapore, 2002.

REFERENCE BOOKS

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing Principles Algorithm and Application", III Edition, Prentice Hall of India, 2005.
2. P. Ramesh Babu, "Digital Signal Processing", IV Edition, Scitech Publications (India) Pvt. Ltd., Chennai, 2007.
3. Mitra Sanjit K., "Digital Signal Processing: A Computer Based Approach", Tata McGraw Hill, New Delhi, 2006.
4. TMS320LF2407 Technical Reference Manual.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X							X		
CO2	X	X	X									
CO3	X	X	X									

13EE65 - DATA COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

The objective of this course is to introduce to the students the tools and techniques of networking queuing models for performance analysis, TCP / IP protocol, broadband networks and Network Security.

COURSE OUTCOMES

At the end of the course the students will be able to:

CO1 *: Learn the concepts of statistics and probability.*

CO2 *: Have an exposure to the techniques for LAN and WAN.*

CO3 *: Solve real world engineering problems.*

INTRODUCTION

Definition of Networks - Classification of Networks - LAN, MAN, WAN, internet - Network Topology - Protocols and Standards - Network Models - OSI, TCP/IP Models of networking - Internet - OSI Model and Functions of layers **(9)**

PHYSICAL LAYER AND THE MEDIA

Review of Signals - Data Rate Limits - Performance Issues - Bandwidth, Throughput, Latency, Bandwidth-Delay Product, Jitter. Digital Transmission and Analog Transmission: Line coding techniques, PCM and Delta Modulation techniques - ASK, FSK, PSK, and QAM Techniques - Bandwidth Utilization: Multiplexing and Spreading - Data Transmission using Telephone Networks - Dial-up MODEMS, Digital Subscriber Line (DSL) **(9)**

ERROR CONTROL AND DATA LINK PROTOCOL

Error Detection and Correction techniques - Data Link Control: Framing, Flow and Error Control - HDLC and PPP protocols. Multiple Access Techniques - CSMA, CSMA/CD, CSMA/CA - Channelization - TDMA, FDMA, and CDMA - Introduction to Queuing Theory. **(9)**

NETWORKS AND SWITCHING

Wired LANs- IEEE 802 standards - Ethernet - IEEE 802.3 MAC Frame - Token Ring LAN - IEEE 802.5 MAC Frame - Wireless LANs - IEEE 802.11 standard - Bluetooth Technology - Interconnection of LANs - Wired WANs - Circuit-Switched Networks, Datagram Networks, Virtual Circuit-Switched Networks, Structure of Circuit and Packet Switches - Wireless WANs - Introduction to Cellular Telephone and Satellite networks **(9)**

NETWORKING DEVICES AND TCP/IP PROTOCOL SUITE

Networking and internetworking devices: Repeaters - Bridges - Gateways - Other devices - Routing algorithms - Distance vector routing - Link state routing-TCP / IP protocol suite: Overview of TCP/IP-Network layers: Addressing - Subnetting - Other protocols and network layers-Application layer: Domain

Name System (DNS) - Telnet - File Transfer Protocol (FTP) - Trivial File Transfer Protocol (TFTP) - Simple Mail Transfer Protocol (SMTP) - Simple Network Management Protocol (SNMP) - email - www. **(9)**

TOTAL : 45

TEXT BOOKS

1. William A.Shay, " Understanding Data Communications and Networks", Brooks /Cole Publishing Company,USA, 2008
2. Behrouz. A. Forouzan, "Data Communication and Networking", IV Edition, Tata McGraw Hill, 2008

REFERENCE BOOKS

1. A.S. Tanenbaum, "Computer Networks",II Edition, Prentice Hall of India, New Delhi, 2003
2. Dimitri Bertzekas and Robert Gallager,"Data Networks", II Edition,Prentice Hall of India",2000.
3. William Stallings, "Data and Computer Communications", V Edition, Prentice Hall of India, New Delhi, 2005.
4. S.Keshav, "An Engineering Approach to Computer Networking", Addision Wesley,1999.

Open Source : NS3, OPNET AND NET SIM, Cisco Packet Tracer, NPTEL

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X				X						
CO2			X					X	X	X		
CO3						X	X	X	X	X	X	X

13EE66 - INDUSTRIAL AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart a blend of skills in mechanical engineering, electronics and computing to comprehend the industrial system design.

COURSE OUTCOMES

CO1 : *The students will be introduced to a concurrent approach in the design of automated system involving different disciplines to achieve more reliable and flexible systems.*

CO2 : *The students can model and simulate plant automation.*

CO3 : *Students will be able to identify suitable automation hardware for the given industrial application.*

BUILDING BLOCKS OF AUTOMATION SYSTEM

Fundamentals of Industrial Automation and Control Elements- Principles and Strategies - Smart Sensors, Transducers and Motion Actuators- PID Controller- Digital Controller.Program of Instructions.Types of production - Functions - Automation strategies - Processing System- multi microprocessor Systems- Local Area Networks- Analog and Digital I/O Modules - Supervisory Control and Data Acquisition Systems - Remote Terminal Unit. Production economics - Costs in manufacturing - Break-even analysis. **(9)**

PROGRAMMABLE CONTROLLERS

Introduction - Relay logic- PLCs-hardware design - Programming PLCs- PLCs -internal operation and signal processing -Programming of PLC Systems. Application to Robotics and FMS - PLC to factory automation - PLC in process control - PLC maintenance - internal PLC faults - faults external to PLC - programmed error - watch dogs - safety - hardware safety circuits - troubleshooting. **(9)**

MODELING AND SIMULATION OF PLANT AUTOMATION

Introduction - Overview of process models - model based automatic control-system modelling-development of mathematical model of plant-modern tools for modelling and simulation of systems-model evaluation and improvement-application examples. **(9)**

DIRECT AND DISTRIBUTED DIGITAL CONTROL

Introduction - DDC Structure -DDC Software - Fundamental requirements of Process Control System - System Architecture - Distributed Control Systems- Configuration -Popular Distributed Control Systems. **(9)**

INDUSTRIAL CONTROL APPLICATIONS

Industrial control Applications- Cement Plant - Thermal power Plant - Water Treatment Plant.Irrigation Canal Management - Steel plant. **(9)**

TOTAL : 45

TEXT BOOK

1. Krishna Kant, " Computer -Based industrial Control ", Prentice Hall of India Pvt. Ltd.,New Delhi,2010.
2. Mikell. P. Groover, “Automation production systems and computer integrated manufacturing” 3rd Edition, Prentice Hall of India, New Delhi, 2011.

REFERENCES

1. David W. Pessen, “Industrial Automation” Circuit Design and Components”, Wiley India Pvt. Ltd., New Delhi, 2011.
2. Ian G. Warnock, "Programmable Controllers operation and Application”, Prentice Hall International, UK, 2008.
3. Richard, L. Shell, “Hand book of Industrial Automation” CRC Press New York, 2009.
4. K.L. Sharma “Overview of Industrial Process Automation” Elsevier, 2011.
5. Tan Kok Kiong, Andi Sudjana Putra,“ Drives & Control for Industrial Automation” Springer, 2010.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X										
CO2		X		X		X			X			
CO3		X	X	X	X	X	X	X	X	X		

13EE67 - POWER ELECTRONICS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

Introduction to concepts involved with Power Electronics Devices and Circuits. Analysis of basic circuits topologies including AC-DC, DC-DC, DC-AC and AC-AC converters. Discussion of the desired outputs of these circuits as well as undesired components such as harmonics and ripple.

COURSE OUTCOMES

CO1 : *To learn the fundamental operation of power electronic devices and to analyze simple power electronic systems.*

CO2 : *To give the students an opportunity to design, evaluate a power electronic converter. To give the students an experience in recording experimental data and displaying results.*

CO3 : *To give the students an appreciation on the current state of power electronic circuits and a realization that there is considerably mere to be learned about power electronics.*

LIST OF EXPERIMENTS

1. Steady State Characteristics of Power Electronic Devices
2. Load Test on Single Phase Half and Fully Controlled Bridge Converters
3. Load Test on Three Phase Half and Fully Controlled Bridge Converters
4. Study of single phase Dual Converter
5. Study of IGBT / MOSFET based Chopper
6. AC Phase Control using SCR and TRIAC
7. Load Test on Single Phase Cyclo Converters
8. Load Test on Series and Parallel Inverter
9. Load Test on IGBT / MOSFET based single phase inverter
10. Load Test on three phase PWM inverter
11. Load Test on buck, boost and buck-boost converter.
12. Simulation of power electronic converters using PSIM/MatLab/SIMULINK.
13. Resonant DC - DC Converter.
14. a) Micor Controller Based Fault Detection in Converter Circuits.
    b) Study of Static Circuit Breakers.
15. Power Quality study on non-linear loads.

16. a) Study of IV characteristics of Solar PV Modules (Series, parallel and Series - Parallel combinations)

    b) Estimating the effect of sun tracking on energy generation by solar PV modules.

17. Efficiency measurement of Standalone solar PV systems.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X		X		X						X	
CO2	X	X	X		X						X	
CO3	X								X	X		

13EE68 - POWER SYSTEMS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To enable the students to understand the operation and characteristics of power system components. To familiarize the students about different protection system.

COURSE OUTCOMES

The students are trained to :

CO1 : *know the performance of different types of relays.*

CO2 : *analyze the parameters and identify the various faults in power system.*

CO3 : *offer solution to mitigate the power quality issues.*

LIST OF EXPERIMENTS

1. Study of Fuse Test
2. Study of DC Battery
3. Cable fault locator study.
4. Relay Control System.
5. Parallel Operation of Generators.
6. Measurement of sequence impedances.
7. Insulating oil Break down Voltage Test.
8. Current Relay.
9. Over Voltage Relay.
10. Under Voltage Relay.
11. Negative sequence Current Relay.
12. Under Frequency Relay
13. IDMT OC Static Relay
14. IDMT Earth fault relay.
15. Instantaneous Over Current Relay.
16. Power Quality Analysis using simulation software.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X					X		X		
CO2	X		X	X	X			X		X		
CO3		X	X	X	X		X	X		X	X	

13EE69 - MINI PROJECT

L	T	P	C
0	0	3	2

ASSESSMENT : VIVA-VOCE

COURSE OBJECTIVE

To obtain knowledge in building and developing a prototype model. To enhance their skills on designing and fabrication.

COURSE OUTCOMES

CO1 : *The student will use their ability to design electrical, electronic systems and signals through modeling, simulation, experimentation, interpretation and analysis to build, test, and debug prototype circuits and systems and analyze results using the principles of design to solve open-ended engineering problems.*

CO2 : *The students will be able to take professional decisions based on the impact of socio-economic issues by their self-confidence, a high degree of personal integrity, and the belief that they can each make a difference by engaging them in team-based activities, and by strengthening their interpersonal skills. This will lead to develop the leadership qualities by making the students to identify their personal values and demonstrate the practice of ethical leadership.*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X	X	X	X				
CO2	X	X	X	X	X	X	X	X	X	X	X	X

13EE71 - ELECTRIC DRIVES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

The course objective is to prepare the students for the process of learning fundamental concept of various electrical drive systems, principle of operation and their sophisticated control schemes.

COURSE OUTCOMES

CO1 : *The students have acquired the selection of fundamental knowledge of various electric drive systems.*

CO2 : *The students can classify the choice of electrical drives for practical applications.*

CO3 : *The students have better understood in the characteristics of various types of motors and their starting, braking, speed control by solid state power converters and uses recent microcontroller/ DSP controller, neural networks and fuzzy techniques.*

CHARACTERISTICS OF ELECTRICAL DRIVES AND LOADS

History and development of drive systems- comparisons-concept of electric drive -block diagram representation - advantages-classification-AC and DC drives-requirements of a good adjustable speed drive - principle factors affecting the choice of drive - speed-torque characteristics of drive motor and load - joint speed-torque characteristics - selection of power rating for drive motor based on thermal overloading and load variation factors - load equalization -starting - braking and reversing for various types of drive motors. **(9)**

DC DRIVES

Introduction-speed control of DC motors - Ward-Leonard scheme and its draw backs -solid state control-advantages-performance parameters- converter fed DC drives - single phase and three phase drives-performance characteristics - single, two and four quadrant operation - supply side harmonics-power factor and effect of ripple on motor performance.

Chopper fed DC drives - chopper fed control of separately excited DC motor and series DC motor - performance characteristics - effects of source current harmonics. **(9)**

AC DRIVES

Methods of speed control of three phase induction motor -Stator Side Control- solid-state control schemes - AC voltage controllers - DC link inverters - cyclo converters- variable speed constant frequency generation-Introduction to vector control.

Rotor Side control: Rotor resistance control- slip power recovery scheme- static Sherbius drive-static Kramer drive - modified Kramer drive.

Synchronous motor drives: Speed control of three phase synchronous motor - true synchronous and self controlled modes - inverter fed synchronous motor drives - commutatorless DC motor - cyclo converter control-synchronous reluctance motor drive. **(9)**

SPECIAL DRIVES

DC servo drives principle of operation - AC servo drives principle of operation - Principle and control Stepper motor drives- comparison between servo drive and stepper drive - Brushless DC motor drives-introduction to PLC based drives-energy efficient drives-switched reluctance motor drives - solar and battery powered drives. **(9)**

DIGITAL CONTROL AND APPLICATIONS OF DRIVES

Digital techniques in speed control - advantages and limitations - control of electric drives using micro controllers and DSP processors - Introduction to fuzzy logic and neural network application in electric drives - reversing drives - selection of drive and control schemes for steel industry-textile industry-mining-paper industry-cement mills-machine tools-control system for elevators and cranes. **(9)**

TOTAL : 45

TEXT BOOKS

1. G.K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, edition, 2010.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2010

REFERENCE BOOKS

1. G.K.Dubey, "Power Semiconductor Controlled Drives" John Wiley and Sons, New York, 1999.
2. VedamSubramaniam,"Electrical Drives and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
3. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2008.
4. S.K.Pillai, "A First Course on Electrical Drives", II Edition, New Age International Publishers, 2010.
5. P.C. Sen, "Thyristor DC Drives", John Wiley and Sons, New York, 1981.
6. J.M.D. Murphy, "Thyristor Control of AC Motor", Paragon Press, London, 1978.
7. M.S.Berde, "Electric Motor Drives", Khanna publishers, New Delhi 1997.
8. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives" CRC Press Taylor & Francis Group, 2010.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X		X								
CO2		X	X			X	X					
CO3		X	X	X								

13EE72 - ROBOTICS AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the fundamentals of robotics, analysis and control of industrial robots.

COURSE OUTCOMES

CO1 *: Identification and selection of major components of a robot to the system specifications.*

CO2 *: Planning the manipulator trajectories based on the dynamic behavior of the robot.*

CO3 *: Designing robot controller with vision and intelligence.*

INTRODUCTION

Evolution of robotics - Laws of robotics - classification - robot anatomy - specification - resolution, repeatability and precision movement. Introduction to robot arm kinematics and dynamics - planning of manipulator trajectories. **(9)**

ROBOTIC DRIVES AND CONTROL

Hydraulic, Electric and Pneumatic drives - linear and rotary actuators - end-effectors -classification-control of robot manipulator - variable structure control - non-linear decoupled and feedback control - effect of external disturbance - PID control scheme - resolved motion control - computed torque control, force control of robotic manipulators. Adaptive control. **(9)**

ROBOTIC SENSORS

Need for sensing system - classification of robotic sensors - status sensors, environmental sensors, quality control sensors, safety sensors and work cell control sensors.- non optical and optical position sensors - velocity sensors - proximity sensors - contact and noncontact type - touch and slip sensors - force and torque sensors - selection of right sensors. **(9)**

ROBOTIC VISION SYSTEMS

Architecture of robotic vision system - stationary and moving camera - image acquisition - image representation - image processing and image segmentation. Object recognition and categorization - pick and place -- visual inspection - need for vision training and adaptation. **(9)**

ROBOTIC DESIGN AND APPLICATIONS

System specification - mechanical description - motion sequence - selection of motor and drive mechanism - controller design - vision system consideration and method of programming. Industrial applications - future scope of robotics - safety in robotics - robot intelligence and task planning - application of AI and knowledge based expert systems in robotics. **(9)**

TOTAL : 45

TEXT BOOK

1. Fu, K.S., Gonzalez RC., and Lee C.S.G., "Robotics control, sensing vision and intelligence", McGraw Hill, Second Reprint, 2008.

REFERENCE BOOKS

1. Kozyrey, Yu. "Industrial Robotics", MIR Publishers Mascow, 1985.
2. Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2005.
3. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G. Odrey, "Industrial Robotics Technology, Programming and Applications ", McGraw Hill, Int 2005.
4. Richard D Klafter Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X	X	X							
CO2				X	X	X					X	
CO3		X	X			X	X					

13EE73 - UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart the knowledge about electric power distribution, utilization and conservation of electrical energy in power system and appliances.

COURSE OUTCOMES

CO1 : *The students are familiar on different types of electric drives, electric traction systems, various lamps and illuminators.*

CO2 : *The students will be able to optimize and design energy saving electrical utilities.*

CO3 : *The students have knowledge to conduct electrical energy audit for industries.*

ILLUMINATION

Laws of illumination - calculation of illumination - street lighting and flood lighting - MSCP -- Choice of lighting - Different types of illumination sources and energy efficiency - control of lighting - lighting standards for industry and commercial - Energy conservation measures for lighting. **(9)**

ELECTRIC TRACTION

Choice of an Electric Motor - Traction Motors - Characteristic - Systems of railway electrification - Power and energy output from driving axles - Specific energy output and consumption - Electric Braking - System of railway electrification - aircraft electrical system. **(9)**

HEATING, WELDING AND ELECTROLYSIS

Methods of electric heating - Resistance heating - Arc furnaces - Induction heating - Dielectric heating. Electric Welding Types - Resistance welding - Arc welding - Electric oven heating.

Faraday's laws of Electrolysis - Application of electrolytic Process - Electroplating - Production of metals - electro forming - Anodizing - Current and Energy Efficiency - Power Supplies - Types of Rectifiers. **(9)**

ELECTRICAL ENERGY AUDIT

Electricity billing, electrical load management and maximum demand control, Energy efficiency in electrical system and energy audit - Energy conservation Act 2001 and its features-energy and demand charges - transmission and distribution losses - reactive power management for power factor correction - Environment and Climate change-Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM - Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF). **(9)**

CONSERVATION OF ELECTRICAL ENERGY

Energy conservation potential in motors-pumps - fans and compressors - refrigeration and HVAC system, operation and maintenance practices for electrical energy conservation- case studies. **(9)**

THEORY : 45

TUTORIAL : 15

TOTAL : 60

TEXT BOOKS

1. C.L. Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International Pvt. Ltd., 2012.
2. J.B. Gupta, "Utilisation of Electric power and Electric Traction", S.K.Kataria and Sons, 2009.

REFERENCE BOOKS

1. N.V. Suryanarayana, Utilisation of Electric power, Wiley Eastern Limited, New Age International Limited, 2004.
2. R.K. Rajput, Utilisation of Electrical Power, Laxmi publications (P) Ltd., 2007.
3. H. Partab, Art and Science of Utilisation of Electrical Energy, DhanpatRai and Co., New Delhi - 2004.
4. Luces M. FualKeribeery, watter coffer, Electrical power Distribution and Transmission, Pearson Education, 1996.
5. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case Study, Hemisphere, Washington, 1980.
6. CB Smith, Energy Management Principles, Pergamon Press, New York, 1981.
7. Bureau & Energy Efficiency, “Energy Efficiency in Electrical Utilities” Guide Book for National Certification Examination for Energy Managers and Energy Auditors, New Delhi, 2013. (www.bee-india.nic.in)

TUTORIALS

1. Study of different types of tariff for LT and HT supply systems.
2. Problems Cost comparison of different distribution systems.
3. Study on wheeling charges.
4. Energy consumption in electric traction for various loads.
5. Study of power consumption of different lighting sources.
6. Design of interior lighting, flood lighting and street lighting.
7. Design of coils for various types of heating system.
8. Problems in amount of energy required in electrolysis.
9. Study of electrical parameters of a loaded feeder for transmission loss calculation.
10. Transformer loading calculation in HT / LT power utilization.
11. Power factor correction at distribution and load end.
12. Energy Audit of a small firm or Laboratory

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X										
CO2		X	X			X						
CO3			X				X	X				

13EE76 - ELECTRIC DRIVES LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

The objective of this laboratory is to equip students with practical knowledge of variable-speed drives and associated control systems which are used in AC and DC Machines. Also the course offers the basic understanding of characteristic of machines driven from appropriate power electronic converters.

COURSE OUTCOMES

CO1 : *The students are capable to apply the theories of electrical machines, power electronic converters and control system design to implement drive systems which are appropriate for specific performances.*

CO2 : *The students have learnt the performance characteristics of AC and DC motors supplied from appropriate converters controlled by DSP and PLC controller.*

CO3 : *The students have understood the quadrant operation of various types of drives and their control requirements.*

CO4 : *The students are capable of detecting faults in converter system using micro controller.*

LIST OF EXPERIMENTS

1. Dynamic Braking Characteristics of DC Shunt Motor
2. Dynamic Braking and Reverse Current Braking Characteristics of Three-Phase Induction Motor
3. Speed Control of DC Motor using Phase Controlled Converter
4. Speed Control of DC Motor using Four Quadrant Chopper fed Drive
5. Speed Control of Induction Motor using Scalar and Vector Controlled Drive
6. Speed Control of DC Motor using Universal Motor Drive
7. DSP Based Speed Control of Three Phase Squirrel Cage Induction Motor
8. PLC based Speed Control of Three Phase Induction Motor drive
9. Performance analysis of Solar PV based DC and AC Pump
10. Study of Special Drives

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X		X	X								
CO2			X		X						X	
CO3		X	X			X	X					

13EE77 - ROBOTICS AND CONTROL LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : THEORY

COURSE OBJECTIVE

To gain the real time practical experience on design and programming of Robot to perform different tasks.

COURSE OUTCOMES

CO1 *: Enhancement of programming skill for deploying the robot towards specific task.*

CO2 *: Optimization of task planning.*

CO3 *: Application specific robot path planning.*

LIST OF EXPERIMENTS

1. Pick and place Robot
2. Line tracking Robot
3. Color sensing Robot
4. Object identifying Robot
5. Obstacle avoidance Robot
6. Fire fighting Robot
7. Home making Robot
8. Plant watering Robot
9. Inspecting Robot
10. Store keeping Robot
11. Design of PID controller for Robot
12. Simulation of Linear system and Stability Analysis

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X			X							
CO2		X	X		X	X						
CO3		X		X	X					X		

13EE81 - INDUSTRIAL MANAGEMENT AND ECONOMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To acquire basic knowledge on economics, demand, supply, pricing, break-even analysis, banking, industrial finance and accounting. To have basic understanding about skills required for industrial management, human resource management, job-analysis, recruitment and training processes. To acquire basic knowledge in marketing and insurance.

COURSE OUTCOMES

Upon completion of this course the students will have

CO1 : *Basic knowledge on economics, demand, supply, pricing, break-even analysis, banking, industrial finance and accounting.*

CO2 : *Knowledge on skills required for industrial management, human resource management, job analysis, recruitment and training processes.*

CO3 : *Basic knowledge in marketing and insurance.*

CO4 : *An understanding of skills required for managerial success and to face the boom and recession in industry.*

ECONOMICS

Definition - Relationship between Economics and Engineering - Demand Analysis and Supply Analysis, Elasticity of Demand and Supply - Cost of Production - Break-even Analysis - Pricing under perfect competition, monopoly and monopolistic market. **(9)**

INDUSTRIAL FINANCE AND ACCOUNTING

Need for Finance, Types of Finance - Sources of Finance -Business cycle and Business policies-Demand Recession in India-Causes, Indicators and Prevention- Stock Exchange. **(9)**

MONEY AND EMPLOYMENT

Estimation of National Income, Methods and Problems - Inflation and Deflation - Unemployment - Money and Changes in Value of Money, Commercial Banks, Central Banking - New Economic Environment - Privatisation, Liberalisation and Globalisation - Importance of Patent Rights. **(9)**

HUMAN RESOURCE MANAGEMENT

Principles of Management, Evolution of Management, Development of Managerial Skills - Human Resource Management - Importance - Objectives - Job Analysis - Recruitment - Selection and Placement and Training Development. **(9)**

MARKETING AND INSURANCE

Marketing - Definition, Aims, Need for Marketing - Marketing function - Marketing management and its functions - Marketing versus Selling - Concept of Insurance - Life Insurance, Fire Insurance, Marine Insurance. **(9)**

TEXT BOOK

1. P.L. Mehta, “Managerial Economics”, S.Chand & Co, 2007.

REFERENCE BOOKS

1. Varshney, R.L and Maheswari,K.L, “Managerial Economics”, S.Chand & Co, 2007.
2. O.P. Khanna, “Industrial Engineering and Management”, Dhanpat Rai Publication (P) Ltd-2006.
3. Philip Kotler, “Marketing Management”, 13th Edition, Pearson Education.
4. R.S.N. Pillai and Bagavathi, “Marketing Management”, Sultan Chand & Sons, 2009.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						X	X	X	X	X	X	X
CO2						X	X	X	X	X	X	X
CO3						X	X	X	X	X	X	X
CO4						X	X	X	X	X	X	X

13EE82 - EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To hone the students in problem solving and system design skills using modeling practices and learn more key concepts in embedded hardware architecture interfaces, buses, programming concepts and RTOS.

COURSE OUTCOMES

CO1 : *The students can develop systems that make optimum use of available system resources namely processor, memory, ports, devices and power.*

CO2 : *The students can apply various serial communication devices, wireless devices and device drivers.*

CO3 : *The students can implement the basics of RTOS and various software development tools for the development of embedded systems.*

INTRODUCTION TO EMBEDDED SYSTEMS

Processor Architecture-Real World Interfacing-Processor and Memory Organization-Instruction Level Parallelism-Performances Metrics-Memory Types-Memory Map and Addresses-Processor Memory Selection **(9)**

DEVICES AND COMMUNICATION BUSES FOR DEVICE NETWORK

Serial Communication Devices-Parallel Device Ports-Wireless Devices-Timer And Counting Devices-WDT-RTC-Networked Embedded Systems-Serial Bus Communication-Bus Device Communication Protocols-Wireless And Mobile System Protocols. Device Drivers-ISR Concept-Interrupt Servicing Mechanism-Multiple Interrupts- Device Driver Programming. **(9)**

PROGRAM MODELING CONCEPTS

DFG Models-State Machine Programming models For Event Controlled Program Low-Modeling of Multiprocessor Systems-UML Modeling. **(9)**

INTER PROCESS COMMUNICATION AND SYNCHRONIZATION PROCESSES, THREADS AND TASKS

Multiple Processes-Threads in an Application-Concepts of Semaphores-Inter process Communication-Signal Function-Semaphores Functions-Message Queue Functions-Mailbox Functions-Pipe Functions-Socket Functions-RPC Functions. **(9)**

RTOS

Services-Process Management-Timer Function-Event Function-Memory Management Device-File And IO Subsystem Management-Interrupt Routines In RTOS Environment And Handling Of Interrupt Source Calls-RTOS Task Scheduling-RTOS I-Micro C/OS II-Vx works-RTOS II-Windows CE-OSEK-Real Time Functions. **(9)**

TOTAL : 45

TEXT BOOK

1. Raj Kamal, "Embedded Systems-Architecture, Programming and Design", Tata McGraw-Hill Education, 2008.

REFERENCE BOOKS

1. Embedded System Architecture- A Comprehensive guide for engineers and Programmers By Tammy Noerguard-Elsevier Publications- Newnes Division of Reed Elsevier India Private Limited, 2011.
2. Embedded System Building Blocks Complete and Ready to use modules in C- Jean J Labrosse-CMP Books, CMP Media LLC, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						X					X	
CO2			X	X	X	X	X	X	X	X	X	
CO3			X	X	X	X	X	X	X	X	X	

13EE83 - VLSI DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the design aspects of VLSI circuits using CMOS devices and programmable logic devices and to familiarize VHDL language for modeling combinational and sequential circuits.

COURSE OUTCOMES

CO1 : *The students can model combinational circuits, sequential circuits and computational elements for a digital system using VHDL language.*

CO2 : *The student can apply the knowledge of basic CMOS circuits and designing techniques of VLSI systems for various programmable devices.*

CO3 : *The student can implement CMOS Logic Design to design VLSI subsystems.*

MOS AND CMOS CIRCUITS

nMOS, pMOS and CMOS Fabrication process - Electrical properties of MOS and BiCMOS circuits - nMOS inverter - pull-up to pull-down ratio - BiCMOS inverter - latch-up in CMOS circuits - stick diagrams - design rules and layout **(9)**

SUB SYSTEM DESIGN

Sheet resistance - capacitive loads - inverter delays - propagation delays - wiring capacitances. Switch logic - gate logic - combinational logic - structured design - clocked sequential circuits - bus drivers - power dissipation for CMOS and BiCMOS circuits - current limitations. **(9)**

VHDL

Introduction to VHDL - design flow - data types - operators - functions and procedures - behavioral modeling - structural modeling - time dimension and simulation - synthesis. **(9)**

HARDWARE MODELING USING VHDL

Combinational logic design using VHDL: Decoders - Encoders - Multiplexers - demultiplexers - adders / subtractors - comparators.

Sequential logic design using VHDL: Flip-Flops - synchronous and asynchronous counters - Finite State Machines - ALU/CPU **(9)**

PROGRAMMABLE LOGIC DEVICES

Programmable Logic Arrays (PLAs) - Programmable Array Logic Devices (PALs) - Complex Programmable Logic Devices (CPLDs) - 22V10 PAL Device - Altera MAX 7000 - Field Programmable Gate Arrays (FPGAs) - Altera Flex 10K, Xilinx XC4000 FPGA family architectures - Xilinx Spartan series FPGAs - Using CAD Tools to implement circuits in CPLDs and FPGAs. **(9)**

TOTAL : 45

TEXT BOOKS

1. Dauglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design", III Edition, Prentice Hall of India, 2001.
2. Stephen Brown and ZvonkoVranesic, "Fundamentals of Digital Logic with VHDL Design", McGraw Hill, Singapore, 2007.

REFERENCE BOOKS

1. Neil H. E. Weste and Kamran Eshragian, "Principles of CMOS VLSI Design: A Systems Perspective", II Edition, Pearson Education Asia Pvt. Ltd., 2004.
2. Douglas L. Perry, "VHDL Programming by Example", IV Edition, Tata McGraw Hill, New Delhi, 2002.
3. Wayne Wolf, "Modern VLSI Design", III Edition, Pearson Education Asia Pvt. Ltd., 2003.
4. John F.Wakerly, "Digital Design Principles and Practices", III Edition, Pearson Education Asia Pvt. Ltd., 2003.

OPEN SOURCE SOFTWARE

Active HDL software for simulation and synthesis for VLSI design.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X	X			X					
CO2			X	X	X	X	X	X	X	X	X	
CO3			X	X	X	X	X	X	X	X	X	

13EE86 - VLSI LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To design and program VLSI circuits using VHDL language for modeling combinational and sequential circuits.

COURSE OUTCOMES

CO1 : *The students can model digital system using VHDL language.*

CO2 : *With the knowledge of the CMOS circuits and designing techniques of VLSI systems the students can implement programmable devices.*

CO3 : *The knowledge of CMOS Logic Design enable the students to design VLSI subsystems.*

LIST OF EXPERIMENTS

1. Design of priority encoder using VHDL
2. Design of 4 bit ripple adder using VHDL
3. Design of 8 bit counter to count values from 0 to F and roll back to 0 using VHDL
4. Design of 4 bit shift register using VHDL.
5. Design of decoder using VHDL code to perform 8 bit decoding operations.
6. Design of 4x1 multiplexer using VHDL code.
7. VHDL program for 4-bit full-adder.
8. VHDL program for 9-bit parity generator.
9. VHDL program to design a 4 bit ALU
10. VHDL process statement that generates a clock with a different on-off period.
11. VHDL program for magnitude comparator.
12. VHDL program for Wallace Multiplier.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X	X	X	X	X	X	X	X	X	
CO2			X	X	X	X	X	X	X	X	X	
CO3			X	X	X	X	X	X	X	X	X	

13EE87 - EMBEDDED SYSTEMS LABORATORY

L	T	P	C
0	0	3	2

ASSESSMENT : PRACTICAL

COURSE OBJECTIVE

To make the students to design and implement embedded controllers for various control applications. To enhance problem solving and system design skills using embedded hardware architecture interfaces, buses, programming concepts and RTOS.

COURSE OUTCOMES

CO1 : *The students can develop systems with the knowledge of the processor architecture.*

CO2 : *The knowledge of serial communication devices, wireless communication enables the students to develop sensor networks.*

CO3 : *The knowledge of RTOS helps in developing embedded systems for a real time application.*

LIST OF EXPERIMENTS

1. Programming PIC microcontrollers using MPLAB and AVR microcontroller
2. Simple programming exercises in PIC microcontrollers
3. I/O Port - flash, rotate right, rotate left, swap operations
4. Interrupts and delay programs using timers.
5. Analog to digital converters using microcontroller.
6. Implementation of embedded sensor network.
7. Implementation of RTOS concepts.
8. Implementation of an application based on wireless communication.
9. Elevator interface.
10. Implementation of an Embedded System
11. Data acquisition and display using ARM.
12. Signal processing using DSPIC.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			X	X	X	X	X	X	X	X	X	
CO2			X	X	X	X	X	X	X	X	X	
CO3			X	X	X	X	X	X	X	X	X	

13EE88 - PROJECT

L	T	P	C
0	0	6	6

ASSESSMENT : VIVA-VOCE

COURSE OBJECTIVE

To congregate the developed skills to model design and implementation of a system, upon developing a system, innovation has to be carried out.

COURSE OUTCOMES

CO1 : *The student will use their ability to design electrical, electronic systems and signals through modeling, simulation, experimentation, interpretation and analysis to build, test, and debug prototype circuits and systems and analyze results using the principles of design to solve open-ended engineering problems.*

CO2 : *The students will be able to take professional decisions based on the impact of socio- economic issues by their self confidence, a high degree of personal integrity, and the belief that they can each make a difference by developing persuasive communication skills in a variety of media by engaging them in team-based activities, and by strengthening their interpersonal skills. This will lead to develop the leadership qualities by making the students to identify their personal values and demonstrate the practice of ethical leadership.*

CO3 : *The students will be able to appreciate the importance of optimization, commercialization, and innovation as the desired features of the designed system.*

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X	X	X	X				
CO2	X	X	X	X	X	X	X	X	X	X	X	X
CO3									X	X	X	X

13ER01 - ADVANCED POWER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To provide a theoretical and practical background in advanced power electronic devices and circuits, with the engineering analysis, design, and laboratory skills. To study the principles of power conditioners, FACTs and Custom Power frequency control, circuit design considerations, and applications of power electronics.

COURSE OUTCOMES

CO1 : *The students can implement the concepts of resonant converters with a theoretical and practical background with the engineering analysis, design.*

CO2 : *Students can attain the knowledge in the FACTs and custom power frequency control, circuit design considerations, and applications.*

CO3 : *Students will have the knowledge of contemporary technical issues in Power electronics field.*

RESONANT CONVERTERS

Zero voltage and zero current switching - classification of resonant converters - basic resonant circuit concepts - load resonant converters - resonant switch converters - zero voltage switching, clamped voltage topologies - resonant DC link inverters and zero voltage switching - high frequency link integral half cycle converters - applications in SMPS and lighting. **(9)**

IMPROVED UTILITY INTERFACE

Generation of current harmonics - current harmonics and power factor - harmonic standards and recommended practices - need for improved utility interface - improved single phase utility interface - improved three phase utility interface - EMI and RFI. **(9)**

POWER CONDITIONERS

Power line disturbances - noise and Surge reduction - power conditioners -static, servo stabilizer, CVTs - uninterruptable power supply(UPS)- types- design of static UPS - filter design. **(9)**

FACTS AND CUSTOM POWER

Introduction - principles of reactive power control in load and transmission line compensation - series and shunt reactive power compensation - concepts of Flexible AC Transmission Systems (FACTS) - static var compensators (SVC) - thyristor controlled reactor - thyristor switched capacitor - solid state power control - static condensers - controllable series compensation - thyristor controlled phase - angle regulator and unified power flow control - modeling and methods of analysis of SVC and FACTS controllers - system control and protection - harmonics and filters - simulation and study of SVC and FACTS under dynamic conditions. **(9)**

EMERGING DEVICES AND CIRCUITS

Power junction field effect transistors - field controlled thyristors - JFET based devices Vs other power devices - MOS controlled thyristors - power integrated circuits - new semiconductor materials for power devices. **(9)**

TOTAL : 45

TEXT BOOK

1. Ned Mohan, et.al, "Power Electronics Converters, Applications and Design", Third Edition, Wiley India, New Delhi, 2012.

REFERENCE BOOKS

1. Timothy. J.E. Miller, "Reactive Power Control in Electric Systems", BSP Books Pvt. Ltd., New Delhi, 2010.
2. Mathur R.M., "Static Compensation for Reactive Power Control", Context Publication, Winnipeg, Reprint Edition, 1986.
3. James W. Clark, "AC Power Conditioners - Design and Applications", Academic Press,Inc, California,1990
4. P.C. Sen, "Modern Power Electronics", 2nd edition S. Chand Publishers, New Delhi, 2005.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X											
CO2	X	X	X		X	X						
CO3	X		X	X	X	X					X	

13ER02 - CRYPTOGRAPHY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

Students can understand the foundations of cryptography, public key and symmetric key cryptosystems. They can understand the mathematics behind various crypto systems and algebraic codes.

COURSE OUTCOMES

CO1 *: They can analyse the cryptographic algorithms for security strengths and weakness.*

CO2 *: They can implement cryptographic algorithm and analyse digital signature algorithm*

CO3 *: They can explore the importance and applications of cryptography in today's society*

INTRODUCTION TO CRYPTOGRAPHY

Computer Security Concepts - OSI Security Architecture - Security Attacks- Security Services - Security Mechanisms - A Model for Network Security -Symmetric Ciphers: Classical Encryption Techniques - Symmetric Cipher Model Substitution Techniques -Transposition Techniques - Rotor Machines - Steganography Block Ciphers and the Data Encryption Standard: Block Cipher Principles - The Data Encryption Standard (DES) - DES -The Strength of DES - Differential and Linear Cryptanalysis- Block Cipher Design Principles -Basic Concepts in Number Theory and Finite Fields Divisibility and the Division Algorithm - The Euclidean Algorithm -Modular Arithmetic - Groups, Rings, and Fields - Finite Fields of the Form GF- Polynomial Arithmetic. **(9)**

ADVANCED ENCRYPTION STANDARD

The Origins AES- AES Structure- AES Round Functions-AES Key Expansion-An AES Example-AES Implementation.Block Cipher Operation: Multiple Encryption and Triple DES- Electronic Codebook Mode -Cipher Block Chaining Mode- Cipher Feedback Mode- Output Feedback Mode -Counter Mode 7 XTS Mode for Block-Oriented Storage Devices-Pseudorandom Number Generation and Stream Ciphers-Principles of Pseudorandom Number Generation-Pseudorandom Number Generators Pseudorandom Number Generation Using a Block Cipher-Stream Ciphers-RC4 234-True Random Numbers. **(9)**

ASYMMETRIC CIPHERS

Fermat's and Euler's Theorems-Testing for Primality-The Chinese Remainder Theorem-Discrete Logarithms-Public-Key Cryptography and RSA- Principles of Public-Key Cryptosystems-The RSA Algorithm.Other Public-Key Cryptosystems: Diffie-Hellman Key Exchange-ElGamal Cryptosystem-Elliptic Curve Arithmetic - Elliptic Curve Cryptography-Pseudorandom Number Generation Based on an Asymmetric Cipher. **(9)**

CRYPTOGRAPHIC DATA INTEGRITY ALGORITHMS

Cryptographic Hash Functions-Applications of Cryptographic Hash Functions-Two Simple Hash Functions-Requirements and Security-Hash Functions Based on Cipher Block Chaining_Secure Hash Algorithm **(9)**

MESSAGE AUTHENTICATION CODES

Message Authentication Requirement- Message Authentication Functions-Message Authentication Codes-Hash Functions: HMAC 375- MACs Based on Block Ciphers: DAA and CMAC Authenticated Encryption: CCM and GCM Pseudorandom Number Generation Using Hash Functions and MACs-Digital Signatures: ElGamal Digital Signature Scheme Schnorr - Digital Signature Scheme-Digital Signature Standard (DSS). **(9)**

TOTAL : 45

TEXT BOOKS

1. William Stallings, "Cryptography And Network Security Principles And Practice", Fifth Edition, Pearson Education, Inc., publishing as Prentice Hall, 2011.
2. Wade Trappe and Lawrence C. Washington," Introduction to Cryptography with Coding Theory", 2nd edition, Pearson Prentice Hall, 2006

REFERENCE BOOKS

1. MihirBellare, Phillip Rogaway,"Introduction to Modern Cryptography", 2005
2. OdedGoldreich,"Foundations of Cryptography" - Cambridge University Press, 2007
3. David Joyner, “Coding Theory and Cryptography" - Springer, 2000.
4. Behrouz A Forouzan, Debdeep Mukopadyay, “Cryptography and Network Security” TMH Education Pvt Ltd., 2011.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X	X							X	
CO2	X	X		X	X	X	X	X	X	X	X	
CO3				X	X	X	X	X	X	X	X	X

13ER03 - DESIGN OF SMALL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To facilitate the students to have in depth knowledge in the design of important machines like servo motors, reluctance motors, universal motors, permanent magnet motors and synchros.

COURSE OUTCOMES

CO1 *: The students can have a good understanding on the design of fractional horse power machines.*

CO2 *: Students would acquire knowledge on the design of DC machines, permanent magnet motors, synchronous motors, induction motors and special motors on completion of this course.*

CO3 *: The students will be able to select and design small machines according to the application.*

DC MACHINES

Design of motors and generators - servomotors. **(9)**

PERMANENT MAGNET MACHINES

Use of ceramic (ferrite) permanent magnet - design and applications. **(9)**

SYNCHRONOUS MOTORS

Design of reluctance type, permanent magnet type and excited type - hysteresis motors. **(9)**

INDUCTION MOTORS

Design of small three-phase induction motors, single-phase induction motors, shaded pole and split phase universal motors. **(9)**

SPECIAL MOTORS

Two-phase servomotors - asynchronous tacho generators - their use as accelerometers - synchros - selsyn - switched reluctance motor. **(9)**

TOTAL : 45

TEXT BOOK

1. C.G.Veinott, "Theory and Design of Small Induction Motors", McGraw Hill, 2000.

REFERENCE BOOKS

1. N.P.Yermolin, "Small Electrical Machines", RajkamalPrakasham Pvt. Ltd., Delhi.
2. P.G. Spreadbury, "Fractional Horsepower Electrical Motors", Sir Issac Pitman and Sons 1957.
3. Shanmugasundaram, G. Ganagadharan and R. Palani, "Electrical Machine Design Data Book", John Wiley, India, 1979.
4. T.J.E. Miller, "Electronic Control of Switched Reluctance Machines", New Publication 2001.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X		X		X							
CO2				X		X	X	X	X	X	X	
CO3				X		X	X	X	X	X	X	

13ER04 - DIGITAL CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To digitize the continuous-time controllers, to design controllers in discrete-time domain, to implement them using digital system such as microcontrollers, personal computers, etc and to analyze the systems and controllers in discrete-time state-space.

COURSE OUTCOMES

At the end of the semester the learners will be able to

CO1 : *analyze systems in discrete-time domain.*

CO2 : *determine the stability of the system in discrete-time domain and apply discrete-time state-space methods in system analysis.*

CO3 : *design a stable system using root locus and Bode plot technique.*

INTRODUCTION

Basic concepts of digital control systems - block diagram - analog to digital and digital to analog conversion - sampling and hold devices - multiplexing - sampling and sampling theorems. **(9)**

Z TRANSFORM

Definition and evaluation - basic properties - inverse Z transform - pulse transfer function - starred Laplace transform - applications. **(9)**

MAPPING BETWEEN Z PLANE AND S PLANE

Representation of poles and zeros in the Z plane - relation between Z plane and S plane - mapping - correspondence between pole location in the Z plane and system time response - analysis of simple loop containing a discrete time controller. **(9)**

STABILITY ANALYSIS AND DESIGN

Jury's stability test -Schurcohn Stability test - discrete root locus - frequency response methods - bilinear transformation - LMI techniques - design using root locus and Bode plot- discrete Nyquist stability criterion. **(9)**

DISCRETE STATE SPACE ANALYSIS

Introduction - state space representation of discrete systems - canonical forms - state transition matrix - solving discrete time state equations. **(9)**

TOTAL : 45

TEXT BOOKS

1. Katsuhiko Ogata, "Discrete-Time Control Systems", II Edition, Pearson Education Asia, Singapore, 2002.
2. Gopal M, "Digital Control and State Variable Methods", III Edition, Tata McGraw Hill Publishing Co.Ltd., New Delhi, 2009.

REFERENCE BOOKS

1. Gene F. Franklin J. David Powell and Michael Workman, "Digital Control of Dynamic Systems", 3rd Edition, Addison Wesley Longman, 2006.
2. Benjamin C. Kuo, "Digital Control Systems", II Edition, Oxford University Press, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X		X	X	X						
CO2				X	X	X	X	X	X	X	X	
CO3			X	X	X	X	X	X	X	X	X	

13ER05 - DIGITAL IMAGE PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To study the image fundamentals, mathematical transforms and image processing techniques necessary for image processing.

COURSE OUTCOMES

CO1 : *With the fundamental knowledge of image processing techniques, the students can carryout projects in image processing and machine vision.*

CO2 : *A deep insight of images could be obtained by implementing various mathematical operations that are performed using transformation.*

CO3 : *The knowledge of image enhancement techniques, image restoration and image segmentation could be utilized in extracting information from satellite images, medical images, etc.*

DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS

Elements of visual perception - image sampling and quantization - relationship between pixels - geometric transformations - Discrete Fourier Transform - Properties of 2D Fourier Transform - FFT - Walsh, Hadamard and Discrete Cosine Transforms - Haar, Slant and KarhunenLoeve Transforms. **(9)**

IMAGE ENHANCEMENT TECHNIQUES

Spatial domain methods: Basic grey level Transformation - histogram equalization - image subtraction - image averaging - Spatial filtering: Smoothing and sharpening - Laplacian filters - Frequency domain filters: Smoothing and sharpening - homomorphic filtering. **(9)**

IMAGE RESTORATION

Model of image degradation / restoration process - noise models - inverse filtering - least mean square filtering - constrained least square filtering - blind image restoration - pseudo inverse - singular value decomposition. **(9)**

IMAGE SEGEMENTATION AND REPRESENTATION

Edge detection - thresholding - region based segmentation - basic morphological operations - Boundary representation: chain codes - polygonal approximation - boundary segments - Boundary descriptors: Fourier descriptors - regional descriptors. **(9)**

IMAGE COMPRESSION

Lossless compression: Variable length coding - LZW coding - Bit plane coding - Predictive coding - DPCM. Lossy Compression: Transform coding - Wavelet coding - Basics of Image compression standards: JPEG and MPEG. Basics of vector quantization. **(9)**

TOTAL : 45

TEXT BOOK

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", III Edition, Prentice Hall of India, 2008.

REFERENCE BOOKS

1. William K Pratt, "Digital Image Processing", John Wiley Publications, NewYork, 2001.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing Analysis and Machine Vision", Brooks Cole Publishing Company, USA, 2001.
3. Arthur R.Weeks, "Fundamentals of Electronic Image Processing", Prentice Hall of India, 2003.
4. Jayaraman S, Esakkirajan S, Veerakumar T, "Digital Image Processing", Tata McGraw Hill, New Delhi, 2009.
5. S. Sridhar, “Digital Image Processing”, Oxofrd University Press, 2011.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X	X	X	X	X	X				
CO2	X	X	X	X							X	
CO3	X	X	X	X	X	X	X	X	X	X	X	

13ER06 - ELECTRONIC PRODUCT DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

This subject provides a framework for developing electronic instrumentation, from hand-held devices to consoles. It offers practical design solutions for Printed Circuit Board fabrication, describes the interactions and priorities encountered in design solutions.

COURSE OUTCOMES

CO1 : *The students will be able to integrate engineering principles with real applications from a systems perspective.*

CO2 : *They would fabricate printed circuit boards intended for projects in industries.*

CO3 : *They would understand the importance of instrument testing.*

ERGONOMICS

Concept of a product - phases of development of an electronic product - pre-study phases, study phase, design, engineering, trial production phases, ergonomics for electronic equipments - definition - anthropometry - ergonomic requirements - ergonomics in industrial electronic equipments. **(9)**

ELECTRONIC COMPONENTS AND NOISE

Electronic components: Resistors, capacitors and inductors - types and characteristics - discrete and integrated circuit packages.

Noise in electronic equipments: Types and sources of electrical noise supply line transients, EMI, ESD and ground noises - radiated and conducted noise - wiring and noise coupling paths - partitioning - grounding - shielding - filtering. **(9)**

ENCLOSURES AND CABLES

Enclosure requirement - materials and various standards - classes of enclosures - signal, power and compensating cables - various types of board connectors. **(9)**

PRINTED CIRCUIT BOARD TECHNOLOGY

Printed Circuit Board materials and standards - manufacturing techniques - general design guidelines for PCBs - design guidelines for analog, digital and power electronic circuit PCBs - Multilayer PCBs - soldering techniques - automation in PCB design and manufacturing - Introduction to SMD technology. **(9)**

INSTRUMENT TESTING

Types of testing - testing against EMI - environmental and mechanical testing - manufacturing cycle - automatic test equipments - quality and reliability. **(9)**

TOTAL : 45

TEXT BOOKS

1. R.G. Kaduskar, V.B. Baru, “Electronic Product Design” 2nd Edition, Wiley India, New Delhi, 2012.
2. Kim R.Fowler, "Electronic Instrument Design", Oxford University Press, NewYork, 2006.

REFERENCE BOOKS

1. Anand M.S., "Electronic Instruments and Instrumentation Technology, Prentice Hall of India, 2004.
2. John R Barnes, "Robust Electronic Design Reference Book", Volumes I and II, Kluwer Academic Publishers, NewYork, 2004.
3. Ott H.W., "Noise Reduction Techniques in Electronic System", John Wiley & Sons, NewYork, 1988.
4. Bruce R Archambeault, "PCB Design for Real-World EMI Control", Kluwer Academic Publishers, NewYork, 2002.
5. MouradSamiha and ZorianYervant, "Principles of Testing Electronic Systems", John Wiley & Sons, NewYork, 2000.
6. Walter C.Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, New Delhi, 2005.
7. Halit Even, “Electronic Portable Instruments Design and Application” C.R.C. Press, Taylor and Francis group 2003.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X											
CO2	X		X	X	X						X	
CO3	X	X	X	X	X		X	X		X	X	

13ER07 - FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To teach the students FACTS technology, which have come into widescale operation and offers further opportunities to improve the control of transmission systems under deregulated environment.

COURSE OUTCOMES

On completion of this subject,

CO1 : *the students would be able to design the FACTS controller devices for improving the power quality.*

CO2 : *the students can realize the impact of FACTS controllers on AC transmission system.*

CO3 : *the students can design the FACTS controllers for reactive power compensation in AC transmission system and improve the quality of power.*

INTRODUCTION

Reactive power control in electrical power transmission lines - Uncompensated transmission line - series compensation - Basic concepts of static VAR Compensator (SVC) - Thyristor Switched Series capacitor (TCSC) - Unified power flow controller (UPFC). **(9)**

STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS

Voltage control by SVC - Advantages of slope in dynamic characteristics - influence of SVC on system voltage - Design of SVC voltage regulator - Applications: Enhancement of transient stability - steady state power transfer - Enhancement of power system damping - prevention of voltage instability. **(9)**

THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS

Operation of the TCSC - Different modes of operation - Modeling of TCSC - Variable reactance model - Modeling for stability studies. Applications: Improvement of the system stability limit - Enhancement of system damping - Voltage collapse prevention. **(9)**

EMERGING FACTS CONTROLLERS

Static Synchronous Compensator (STATCOM) - Principle of operation - V-I Characteristics - Unified Power Flow Controller (UPFC) - Principle of operation - Modes of Operation - Applications - Modeling of UPFC for Power Flow Studies. **(9)**

CO-ORDINATION OF FACTS CONTROLLERS

Controller interactions - SVC - SVC interaction - Co-ordination of multiple controllers using linear control techniques - Control coordination using genetic algorithms. **(9)**

TOTAL : 45

TEXT BOOK

1. Mohan Mathur R, Rajiv K Varma, Thyristor - Based Facts Controllers for Electrical Transmission Systems, IEEE press and John Wiley & Sons, Inc., 2002, Reprint 2009.

REFERENCE BOOKS

1. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
2. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTS”, Wiley-IEEE Press, 2001.
3. K.R.Padiyar, "Facts Controllers In Power Transmission and Distribution", New Age International, 2007.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X							
CO2							X	X				
CO3						X	X	X	X	X	X	

13ER08 - HIGH SPEED NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce to the students the concept of Quality of Service, ATM networks, DSL, performance analysis using queuing models, Issues and protocols for routing and traffic management.

COURSE OUTCOMES

CO1 *: Describe and interpret the basics of high speed networking technologies.*

CO2 *: Describe the knowledge of network planning and optimization.*

CO3 *: Apply the concept learnt in this course to optimize and troubleshoot high speed network.*

INTRODUCTION TO QoS

Introduction - need for speed and quality service - protocol and network fundamentals - packet switching and frame relay networks. **(6)**

ATM AND DSL

High-speed networks - ATM - ATM protocol architecture - ATM logical connections - ATM cells - digital subscriber link (DSL) - asymmetric DSL (ADSL) - high bit rate DSL (HDSL) - VHDSL - symmetric DSL (SDSL) - rate adaptive DSL (RADSL) - high speed LAN - fast Ethernet - gigabit internet - ATM LAN.**(10)**

PERFORMANCE ANALYSIS

Performance modeling and estimation - queuing analysis - queuing models - single server queues - multi server queues - self similarity - self similar data traffic modeling and estimation of self-similar data traffic. **(11)**

TRAFFIC MANAGEMENT

Traffic management - link level flow and error control - link control mechanisms - ARQ performance - transport level traffic control - transmission control protocol (TCP) over ATM - real time transport protocol - TCP/IP Performance over optical networks. **(9)**

ROUTING

Internet routing - overview of graph theory - least cost path - concept of graph theory - shortest path length determination - routing protocols - routing for high speed and multimedia traffic - Satellite Broadcasting. **(9)**

TOTAL : 45

TEXT BOOKS

1. William Stallings, "High Speed Networks - TCP/IP and ATM Design Principles", Prentice Hall of India, 2008.
2. DimitriBertsekas and Robert Gallager, "Data Networks", II Edition, Prentice Hall of India, 2011.

REFERENCE BOOKS

1. Tere Parnell, "Building High Speed Networks", Tata McGraw Hill, 2000.
2. S.Keshav, "An Engineering Approach to Computer Networking", Addison Wesley, 2010.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X								X			
CO2				X	X	X	X	X	X	X	X	
CO3		X	X	X	X	X	X	X	X	X	X	

13ER09 - HIGH VOLTAGE TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the concepts, advantages and limitations of EHVAC and HVDC transmissions, modeling, analysis and operation of EHVAC and HVDC systems and to study the origin of over voltage in EHV systems and EHV cables and their protections.

COURSE OUTCOMES

CO1 : *The students have learnt the advantages, disadvantages and limitations of High Voltage (HV) transmission systems.*

CO2 : *They will have an exposure on the cables used in HV transmission systems and learn the operational features of EHVAC and HVDC systems.*

CO3 : *The Students have acquired the knowledge of multiterminal DC system, use of filters for EHVAC and DC systems.*

EHV AC AND HVDC TRANSMISSION - INTRODUCTION

Introduction to EHV AC and HVDC transmission - comparison between HVAC and HVDC overhead and underground transmission scheme - standard transmission voltages - factors concerning choice of HVAC and HVDC transmission - block diagram of HVAC and HVDC transmission schemes. **(6)**

EHV LINE CONDUCTORS

Properties of bundled conductors - inductance and capacitance of EHV lines - surface voltage gradient on single, double and more than three conductor bundles - corona effects - power loss - increase in radius of conductor - charge voltage diagram - qualitative study of corona pulses, their generation and properties. **(8)**

EHV AC SYSTEMS

Properties of EHV AC transmission at power frequency - generalized constants - power circle diagram and its use - voltage control using compensators - high phase order transmission. **(8)**

HVDC SYSTEMS

Review of rectification and inversion process - constant current and constant excitation angle modes of operations - analysis of DC transmission systems - harmonics on AC and DC sides and filters for their suppression - multi terminal DC transmission systems - parallel operation of AC and DC transmission systems - modern developments in HVDC transmission. **(12)**

OVER VOLTAGES & EHV CABLES

Over voltage in EHV systems, origin and types - ferro resonance over voltage - switching surges - reduction of switching surges - reduction of switching surges on EHV systems - introduction to EHV cable transmission - electrical characteristics of EHV cables - properties of cable insulation materials - EHV insulators - characteristics and pollution performance - protection of HVAC and HVDC systems. **(11)**

TOTAL : 45

TEXT BOOKS

1. S.Rao, "EHV AC and HVDC Transmission Engineering and Practice", I Edition, Khanna Publishers, Delhi, 1990.
2. Rakesh Das Begamudre, "EHV Transmission Engineering", Wiley Eastern Limited, 1990.

REFERENCE BOOKS

1. T.J.E. Miller, "Reactive Power Control in Electric Systems". John Wiley and Sons, New York, 1982.
2. G.K.Dubey, S.R.Doraida, A.Joshi, and R.H.K.Sinha, "Thyristorised Power Controllers", Wiley Eastern Limited, 1992.
3. C.Adamson and N.G.Hingorani, "HVDC Power Transmission", Garrowy Limited, England, 1960.
4. E.W.Kimbark, "Direct Current Transmission - Volume I", Wiley Interscience, 1971.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		X	X			X	X					
CO2					X	X	X	X				
CO3		X			X	X	X	X	X	X	X	

13ER10 - LINEAR AND NON LINEAR SYSTEMS THEORY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce the state-space concept, modeling of physical system in state-space, design controllers in state-space and also to introduce the concepts of nonlinearity, analysis of nonlinear systems.

COURSE OUTCOMES

CO1 : *At the end of the course the learner will be able to model physical system in different types of state models, convert one state model into another state model, determine transfer function model from state model and find solution of state model.*

CO2 : *They will be able to plot the phase portraits of nonlinear systems, analyze nonlinear systems using describing function methods and analyze the satiability of linear and nonlinear systems using Liapunov stability theorem.*

CO3 : *The students will be able to design control systems in state space.*

STATE-SPACE ANALYSIS

Overview of classical control systems - advantages of state model - concepts of state, state variables and state model - state model for linear time-invariant continuous time systems - transfer function from state model - state transition matrix - properties - solution of state equations. **(9)**

DESIGN OF CONTROL SYSTEMS IN STATE-SPACE

Linear transformation - invariance of state model - concept of controllability and observability - controllable and observable canonical forms - Kalman and Gilbert tests - pole-placement by state feedback - Ackermann's formula - full order and minimum-order state observers. **(9)**

PHASE-PLANE ANALYSIS

Nonlinear systems - common physical nonlinearities - jump resonance - phase plane and phase portraits - singular points - types - construction of phase trajectories: analytical, isoclines, delta methods - limit cycle oscillations - stability analysis. **(9)**

DESCRIBING FUNCTION METHOD

Basic concepts - derivation of describing functions for saturation, dead-zone, backlash, ideal relay, relay with dead-zone, relay with saturation, relay with hysteresis - stability analysis by describing function.**(9)**

LIAPUNOV STABILITY ANALYSIS

Concepts of definiteness of sign - quadratic forms - Liapunov theorems on the stability and instability of nonlinear systems - asymptotic stability of linear systems by the second method of Liapunov -Krasovskki's theorem on the global asymptotic stability of nonlinear systems - variable-gradient method for generating Liapunov functions **(9)**

TOTAL : 45

TEXT BOOKS

1. J. Nagrath and M.Gopal, "Control Systems Engineering", IV Edition, New Age International, New Delhi, 2006.
2. Roy Choudhury D, "Modern Control Engineering", Prentice Hall of India, New Delhi, 2009.

REFERENCE BOOKS

1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
2. John E. Gibson, "Nonlinear Automatic Control", McGraw-Hill Book Company, Inc, 1963.
3. Hassan K. Khalil, "Nonlinear Systems", 3rd Edition, Prentice Hall, 2001.
4. Shankar Sastry, "Nonlinear Systems", 1st Edition, Springer, 1999.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X			X	X	X					
CO2	X		X		X	X	X	X	X	X		
CO3			X	X	X	X	X	X	X	X	X	

13ER11 - LOW POWER VLSI DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the design aspects of low power VLSI circuits, architectural level methodologies and software design for low power architecture.

COURSE OUTCOMES

CO1 : *The student can gain the knowledge of low voltage CMOS VLSI technology, BiCMOS and SOI CMOS technology.*

CO2 : *The students can apply recent trends in low-power design for mobile and embedded application.*

CO3 : *The students will be able to apply the algorithms and architectural level methodologies to design low power VLSI circuits.*

INTRODUCTION

Introduction - Need for low power VLSI chips, Sources of power dissipation, Dynamic power dissipation, Charging and discharging of capacitance, Short circuit current in CMOS circuits, CMOS leakage current, Static current. **(9)**

POWER ANALYSIS METHODS

Power analysis- Gate-Level, Architecture level and Data correlation analysis. Monte Carlo Simulation. Probabilistic power analysis. Low voltage CMOS VLSI technology - BiCMOS and SOI CMOS technology. **(9)**

POWER REDUCTION AT THE CIRCUIT LEVEL

Transistor and gate sizing, Equivalent pin ordering, Network restructuring and reorganization, Special latches and Flip Flops, Low power digital cell library, Adjustable device threshold voltage-Low voltage circuits-voltage scaling-sub threshold operation of MOSFETs. **(9)**

POWER REDUCTION AT THE ARCHITECTURE AND SYSTEM LEVEL

Power and performance management, switching activity reduction, Parallel architecture with voltage reduction, Flow graph transformation. Low power SRAM architectures. Software design for low power architecture. Recent trends in low-power design for mobile and embedded application. **(10)**

ALGORITHM AND ARCHITECTURAL LEVEL METHODOLOGIES

Introduction, design flow, algorithmic level analysis and optimization, Architectural level estimation and synthesis. **(8)**

TOTAL : 45

TEXT BOOKS

1. Gary K Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic Publishers,1998.
2. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI design”, John Wiley & Sons, 2009.

REFERENCE BOOKS

1. Anantha P Chandrakasan, Robert W Brodersen, “Low Power Digital CMOS Design”, Kluwer Academic Publications,1995.
2. Kuo J B and Lou J H, “Low Voltage CMOS VLSI Circuits", John Wiley & Sons,1999

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X			X			X					
CO2				X			X	X	X	X	X	
CO3				X			X	X	X	X	X	

13ER12 - MEDICAL ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To teach the students the concepts of medical electronic equipments and applications.

COURSE OUTCOMES

CO1 : *Upon completion of this course, students know about the physiology and anatomy of human system.*

CO2 : *The student would know about the medical equipment maintenance and management.*

CO3 : *The students gains knowledge in analyzing the cardiac, respiratory and neuro problems.*

BIO-POTENTIAL ELECTRODES

Electrode electrolyte interface, resting and action potentials, polarisation and non- polarisable electrodes, calomel electrode, needle electrode, microelectrode biological amplifiers, lead systems and recording systems. **(9)**

CARDIAC SYSTEM

ECG sources - normal and abnormal waveforms, cardiac pacemaker-external pacemaker, implantable pacemaker, different types of pacemakers, fibrillation, defibrillator, AC defibrillator, DC defibrillator, arrhythmia monitor. **(9)**

NEUROLOGICAL SYSTEM AND SKELETAL SYSTEM

EEG - wave characteristics, frequency bands, spontaneous and evoked response. Recording and analysis of EMG waveforms, muscle and nerve stimulation, fatigue characteristics. **(9)**

RESPIRATORY MEASUREMENT AND VENTILATOR

Spirometer, Heart-Lung Machine, Oxygenators, Pnemograph, Artificial Respirator - IPR type, functioning. - Ventilators, Dialysis Machine - Blood Gas Analyser - Po2, Pco2, measurements. **(9)**

THERAPHATIC AND MONITORING INSTRUMENTS

Electromagnetic and ultrasonic blood flowmeter, equipments of physiotheraphy - Transcutaneous Electric Nerve Stimulator(TENS) - ultrasonic theraphy- extra corporial shockwave lithotripsy- diathermy - audiometers - MRI- CT scan - continous patient monitoring system - Medical Equipment Maintenance and Management. **(9)**

NOTE : A Term paper is to be submitted about a current topic in this field.

TOTAL : 45

TEXT BOOKS

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2010.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 1997.

REFERENCE BOOKS

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2011.
2. Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and sons, New York, 1997.
3. Prof. Venkataram S.K., "Biomedical Electronics and Instrumentation", Galgotia Publications Pvt. Ltd., 2000.
4. Arumugam M, "Biomedical Instrumentation", Anuradha Publishers, 2003.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X							X			
CO2				X		X	X	X	X	X	X	
CO3				X	X	X	X	X	X	X	X	

13ER13 - MODELING AND ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the dynamics of operation of electrical machines under normal and abnormal conditions.

COURSE OUTCOMES

CO1 : *Students will demonstrate an understanding of the fundamentals of electromagnetic energy conversion.*

CO2 : *Students will be able to use standard methods to determine accurate modeling/simulation parameters for various general-purpose electrical machines.*

CO3 : *Students will be able to design the general /special purpose electrical machines.*

PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION

Magnetic circuits - stored magnetic energy, co-energy - force and torque - singly and doubly excited system - MMF pattern for DC and AC machines - calculation of air gap mmf and per phase machine inductance using physical machine data. **(9)**

DC MACHINES

Voltage and torque equations - dynamic characteristics of permanent magnet and shunt DC motors - state equations - solution of dynamic characteristics by Laplace transformation. **(9)**

REFERENCE FRAME THEORY

Static and rotating reference frames - transformation of variables - reference frames - transformation between reference frames - transformation of a balanced set - balanced steady state phasor and voltage equations - variables observed from several frames of reference. **(9)**

INDUCTION MACHINES

Voltage and torque equations in machine variables - transformation in arbitrary reference frame - voltage and torque equation in reference frame variables - analysis of steady state operation - free acceleration characteristics - dynamic performance for load variations - computer simulation. **(9)**

SYNCHRONOUS MACHINES

Voltage and torque equation in machine variables - transformation in rotor reference frame (Park's equation) - voltage and torque equation in reference frame variables - analysis of steady state - dynamic performance for load variations - computer simulation. **(9)**

TOTAL : 45

TEXT BOOKS

1. Paul C.Krause, Oleg Wasyzczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, Second Edition, 2005.
2. R.Krishnan, "Electrical Motor Drives, Modelling, Analysis and Control", Prentice Hall of India, 2002.

REFERENCE BOOKS

1. A.E.Fitzgerald, Charles Kingsley, Jr. and Stephen D.Umans, "Electric Machinery", Tata McGraw Hill, 5th Edition 1992.
2. Subramanyam V., "Thyristor Control of Electric Drives", Tata McGraw Hill Publishing Company Limited, New Delhi 1998.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X											
CO2	X	X	X	X	X							
CO3	X	X	X	X	X	X	X				X	

13ER14 - POWER QUALITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

Introduction and analysis of power quality and harmonic phenomena in electric power systems: characteristics and definitions, voltage sags, electrical transients, harmonics, mitigation techniques, standards of power quality and harmonics.

COURSE OUTCOMES

CO1 : *The students will have thorough understanding of the concept of utility distribution and industrial electric power quality phenomena.*

CO2 : *They are proficient in the analysis of power quality disturbances: voltage sags, motor starting, transient phenomena, and harmonics.*

CO3 : *They are fully trained in designing and evaluating the solutions to mitigate power quality disturbances.*

INTRODUCTION TO POWER QUALITY

Power Quality definition - Need for power quality - sensitive loads - Non linear loads - inter connected power systems - Deregulation - Power quality characteristics - types of power quality problems - Transients- Impulsive, Oscillatory - Voltage Variations-Short, Long Duration-Voltage Imbalance-Waveform Distortions: - DC Offset, Harmonics, Notching, Noise - Power Frequency Variations. Sources of power quality problems - Effects of power quality problems - Responsibilities of the suppliers and user of electrical power - power quality standards- Computer Business Equipment Manufacturers Associations (CBEMA) and ITIC curves- Cost of Poor Power Quality. **(7)**

TRANSIENTS

Definition - Power system transient model - Parameters-types - Causes of transients -Sources- Internal- Capacitor switching transients- Transients from load switching- External - Lightning transients - Effects of transients- Mitigation- Principles of Protection -Insulation Coordination - Devices for over voltage protection- Standards. **(8)**

SHORT AND LONG DURATION INTERRUPTIONS

Short duration interruptions - Definition - Magnitude, Duration - Causes of voltage sag, swell and interruption -Sources of voltage sag and short interruptions - Voltage during fault and post fault period, Current during fault period - Effects of voltage sag and short interruptions- Overview of mitigation methods(Qualitative treatment only)-Standards and voltage sag indices.

Long duration interruptions-Definition - Failure, Outage, Interruption - Origin of interruptions - Causes of long interruptions - Principles of regulating the voltage - Voltage regulating devices, Applications : Utility side, End-User side -Reliability evaluation - Cost of interruptions. **(12)**

HARMONICS AND GROUNDING

Harmonics-Description of the Phenomena -Parameters- Voltage Distortion - Current Distortion - Definitions and terms -Sources of Current and Voltage - Harmonics Sources - Effects of Harmonics- - Guidelines for harmonics voltage and current limitation- standards and measures IEEE and IEC standards.

Harmonic filters:Harmonic Distortion Evaluations-Devices for Controlling Harmonic Distortion

Passive, Active and hybrid filters (Qualitative treatment only)-Case Studies.

Grounding-Definitions and terms -Typical Earthing System- Reasons for grounding - National Electrical Code (NEC) grounding requirements - Utility Power system grounding - End-User power system grounding - Typical Wiring and Grounding Problems-Solutions to Wiring and Grounding Problems. **(11)**

POWER QUALITY MONITORING AND SURVEY

Introduction - Power quality monitoring- Monitoring Considerations - Evolution of power quality monitoring - Brief introduction to power quality measurement equipments - Planning, Conducting and Analyzing power quality survey - Assessment of Power Quality Measurement Data - Utility-Customer interface-Introduction to thermo graphy in power quality assessment-Industrial Case Studies-Power Quality Monitoring Standards. **(7)**

TOTAL : 45

TEXT BOOKS

1. Roger.C. Dugan, Mark.F. McGranagham, Surya santoso, H. Wayne Beaty, "Electrical Power Systems Quality", Tata McGraw Hill, 2012.
2. C.Sankaran, "Power Quality" CRC Press, 2011, New York

REFERENCES

1. Angelo Baggini, "Handbook of Power Quality" John Wiley & Sons, New York 2011.
2. Barry W. Kennedy, "Power Quality Primer" MC Graw Hill Publications, New York. 2006
3. M.H.J. Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", Wiley, 2011.
4. J.Arrillage, N.R.Watson And S.Chen, "Power System Quality Assessment", John Wibey&Sons 2000, New York.
5. Derek.A.Paice, "Power Electronic Converter Harmonics", IEEE Industrial Application Society, IEEE Press, New York 1996.
6. Short.T.A., "Distribution Reliability and Power Quality", CRC Press Taylor and Francis Group, 2006.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X											
CO2	X	X			X		X					
CO3	X	X	X	X	X	X		X			X	

13ER15 - POWER SYSTEM CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To familiarize various control actions to be implemented to meet the variations of system load. To understand and model real and reactive power controls. To get an overview of economic dispatch and to have an introductory knowledge in recent trends of power system controls.

COURSE OUTCOMES

The students will be able to

CO1 : *understand control of real power and reactive power by frequency and voltage control.*

CO2 : *learn computer control of power systems and learn economic dispatch control techniques.*

CO3 : *realize the societal needs and professional ethics in power system reliability*

INTRODUCTION

Need for voltage and frequency regulation in power system - system load characteristics - basic P-f and Q-v control loops - cross coupling between control loops - plant level and system level controls - recent trends of real-time control of power systems. **(5)**

REAL POWER AND FREQUENCY CONTROL

Fundamentals of speed governing mechanisms and modeling - speed - load characteristics - regulation of two synchronous machines in parallel - control areas -LFC control of a single area - static and dynamic analysis of uncontrolled and controlled cases - multi-area systems - two area system modeling - static analysis -uncontrolled case - tie line with frequency bias control of two-area and multi-area system - steady state instabilities. **(15)**

REACTIVE POWER - VOLTAGE CONTROL

Typical excitation system - modeling - static and dynamic analysis - stability compensation - effect of generator loading - static shunt capacitor/reactor VAR compensator, synchronous condenser, tap-changing transformer - static VAR system - modeling - system level voltage control. **(8)**

COMPUTER CONTROL OF POWER SYSTEMS

Energy control center functions - system hardware configuration SCADA system - functional aspects - security monitoring and control - system states and their transition - various controls for secure operation. **(10)**

ECONOMIC DISPATCH CONTROL

Incremental cost curve - co-ordination equations with loss and without losses, solution by iteration method. (No derivation of loss coefficients). Base point and participation factors. Economic controller added to LFC control. **(7)**

TOTAL : 45

TEXT BOOKS

1. OlleI.Elgerd, “Electric Energy and System Theory - An Introduction”, Tata McGraw Hill Publishing Company, New Delhi. 1983.
2. Kirchmayer.L.K. 'Economic operation of power system', John Wiley & Sons, 1979.

REFERENCE BOOKS

1. Allen J.Wood, Bruce F. Wollenberg, “Gerald B.Sheble Power Generation Operation and Control”, John Wiley and Sons, 2013.
2. Mahalanbis, A.K., Kothari, D.P and Ahson, S.I., “Computer Aided Power System Analysis and Control”, Tata McGraw Hill Publishing Company, New Delhi, 1990.
3. Kundur, “Power System Stability and Control”, McGraw-Hill Pub. Co., 1994.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X									
CO2	X	X	X	X	X							
CO3	X	X	X	X	X	X	X	X	X	X		

13ER16 - POWER SYSTEM ECONOMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To provide a comprehensive up-to-date economics frame work for understanding the critical issues associated with power system.

COURSE OUTCOMES

The learners will be able to

CO1 : *formulate the objective function with constraints for conventional power generation systems*

CO2 : *manage the available power to meet the load variations through optimal load sharing.*

CO3 : *contribute to the national progress by effective implementation of the concepts of power system economics.*

INTRODUCTION

Operational problems of power system - review of economic dispatch and loss formula calculations. **(9)**

OPTIMAL POWER FLOW

Formulation of OPF problem - cost minimization - loss minimization - solution using NLP methods - successive LP methods. **(9)**

HYDRO THERMAL COORDINATION

Long range and short range hydro scheduling - A gradient approach - hydro units in series - pumped storage hydro plants - solution method used in iteration and dynamic programming. **(9)**

UNIT COMMITMENT

Constraints in unit commitment - thermal unit constraints - hydro constraints - solution methods - priority list methods - dynamic programming solution. **(9)**

MAINTENANCE SCHEDULING

Preparation of maintenance schedules for generating units - turbines - boilers - taking into account forced outages and normal outages - optimal maintenance - scheduling - using mathematical programming. **(9)**

TOTAL : 45

TEXT BOOK

1. L.K. Kirchmayer, "Economic Operation of Power Systems", John Wiley and Sons Inc., New York, 1958.

REFERENCE BOOKS

1. Allen J. Wood and Bruce F.Wollenberg, Gerald B. Sheble, "Power Generation, Operation and Control", John Wiley and Sons, New York and Singapore, 2013.
2. P.S.R.Murthy, "Power System Operation and Control", Tata McGraw Hill, New Delhi, 1984.
3. L.K. Kirchmayer, "Economic Control of Interconnected Systems", John Wiley and Sons, New York, 1959.
4. O.I. Elgerd, "Electric Energy System Theory An Introduction", Tata McGraw Hill, New Delhi, 1983.
5. A.R. Berger, "Power System Analysis", Prentice Hall, New Jersey, 1986.
6. A.K.Mahalanabis, D.P.Kothari and S.I.Ahson, "Computer Aided Power System Analysis and Control", Tata McGraw Hill, New Delhi, 1990.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X							
CO2	X	X	X	X	X	X	X	X	X	X		
CO3			X	X	X	X	X	X	X	X	X	

13ER17 - RESTRUCTURED POWER SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To impart the students the latest advancements in power system industry around the world. The subject covers the restructuring and deregulation of the power utility industry to meet the technological and regulatory changes under globalization.

COURSE OUTCOMES

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

CO1 : *understand the world electricity market scenario in restructured environment, the trading concepts, electricity pricing under deregulated environment.*

CO2 : *get trained to price the model in restructured power system market.*

CO3 : *to realize the power system reforms that are happening*

INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY

Reasons for restructuring / deregulation of power industry - Understanding the restructuring process - Reasons and objectives of deregulation of various power systems across the world: The US, The UK, The Nordic Pool, The developing countries - Fundamentals of Economics - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production - Total cost (TC), Average fixed cost (AFC), Average variable cost (AVC), Average cost (AC), Marginal cost (MC)- The Philosophy of Market Models - Market models based on contractual arrangements - Market architecture: Timeline for various energy markets, Bilateral / forward contracts, The spot market - Models for trading arrangements - ISO or TSO model. **(9)**

TRANSMISSION CONGESTION MANAGEMENT

Definition of congestion - Reasons for transfer capability limitation - Importance of congestion management in deregulated environment - Effects of congestion - Desired features of congestion management schemes - Classification of congestion management methods - Calculation of ATC using PTDF and LODF based on DC model - Calculation of ATC using AC modelNon-market methods : Capacity allocation on first come first served basis, Capacity allocation based on pro-rata methods, Capacity allocation based on type of contractMarket based methods: Explicit auctioning, Coordinated auctioningNodal pricing and its implications - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method **(9)**

PRICING OF TRANSMISSION NETWORK USAGE AND LOSS ALLOCATION

Power wheeling - Issues involved- Principles of transmission pricing - Classification of transmission pricing methods - Rolled-in transmission pricing methods: Postage stamp method, Incremental postage stamp method, Contract path method, MW-Mile method,

Distance based - Power flow based - Power flow tracing - Marginal transmission pricing paradigm - Composite pricing paradigm - Introduction to loss allocation - Classification of loss allocation methods. **(9)**

MARKET POWER AND GENERATORS BIDDING

Attributes of a perfectly competitive market -The firm's supply decision under perfect competition - Imperfect competition: Monopoly, Oligopoly - Electricity markets under imperfect competition - Market power : Sources of market power, Effect of market power, Identifying market power, Market power mitigation - Introduction to optimal bidding by a generator company - Bidding in real markets - Optimal bidding methods. **(9)**

REFORMS IN INDIAN POWER SECTOR

Framework of Indian power sector : Historical Developments, The Institutional Framework, Operational Demarcation of the Power System, National and Transnational Grids - Reform initiatives during 1990-1995: The Independent Power Plants, Orissa Reform Model, Accelerated Power Development and Reforms Program (APDRP), Public-Private Partnership - The availability based tariff (ABT)

The Electricity Act 2003 - Provisions in the generation sector, the transmission sector, the distribution sector, Power trading, Open Access issues - Power exchange - Reforms in near future. **(9)**

TOTAL : 45

TEXT BOOKS

1. Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
2. Daniel Kirschen and Goran Strbac, "Fundamentals of Power System economics" John Wiley & Sons Ltd, 2004.
3. http://nptelonlinecourses.iitm.ac.in

REFERENCE BOOKS

1. Sally Hunt, "Making competition work in electricity", John Wiley & Sons, Inc., 2002.
2. Marjia Ilic, Francisco Galiana and Lester Fink, "Power systems restructuring engineering and economics", Kluwer academic publishers, 1998.
3. Zaccour G, "Deregulation of Electric Utilities", Kluwar Academic Publisher, 1998
4. Mohammad Shahidehpour, M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", CRC Press, 2001
5. S. A. Khaparde, A.R. Abhyankar, "Restructured Power Systems", Alpha Science International Publications, 2006

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X							
CO2	X	X	X	X	X	X	X	X	X	X		
CO3	X	X	X	X	X	X	X	X	X	X	X	

13ER18 - SMART GRID

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

This course series will examine a set of emerging concepts, technologies, applications and business models and the complex trade-off decisions related to transforming the nation's centralized power grid into a more climate, sustainable-energy and consumer-friendly "Smart Grid."

COURSE OUTCOMES

Students will develop knowledge and skills in communications and information technologies for Smart Grid. At the conclusion of the course, students will be able to:

CO1 *: Understand concepts and principles of communications technologies for smart grid*

CO2 *: Analyze the trade-off of different communication architectures and protocols*

CO3 *: Understand the data management issues associated with smart grid*

CO4 *: Understand the security issues in smart grid and solution approaches.*

INTRODUCTION

Review Basic Elements of Electrical Power Systems: - The Origins of the Power Grid - Today's Grid Vs the Smart Grid - A Primer on Today's Electrical Utilities - Desirable Traits of a Modern Grid - Principal Characteristics of the Smart Grid - Representative Architecture of Smart Grid - Functions of Smart Grid and its Components - Overview of the technologies required for the Smart Grid - Smart Grid Market Drivers - Stakeholders Roles and Function - Standards for Smart Grid. **(9)**

SENSING, MEASUREMENT AND CONTROL

Sensor Networks - Communications and Measurement - Wide Area Monitoring Systems (WAMS) - Phasor Measurement Units (PMUs) - GIS and Google Mapping tools - Smart Meters - Smart Appliances - Advanced Metering Infrastructure (AMI) - Advanced Meter Management - Demand side integration - Distribution automation and management: Intelligent electronic devices (IEDs) - SCADA - RTU - distribution system modeling - Fault Detection, isolation and restoration - Self Healing Systems. **(9)**

INFORMATION AND COMMUNICATION TECHNOLOGY

Communication Technology - Two-way Digital Communications Paradigm - Mobile Communications - Multi Protocol Label Switching - Power Line Communications - Standards for Information Exchange : standards for smart metering - MODBUS-DNP3-IEC 61850 - Communication Infrastructure and Protocols for Smart metering: Home Area Networks (HAN) / Home Energy Networks (HEN) - Neighborhood area network - meter data management system - Interoperability : model for Interoperablility - Benefits and Challenges - smart grid network Interoperability - standards.

Cyber Security : Symmetric key encryption - public key encryption - authentication - cyber security concerns associated with AMI - Cyber Security Challenges in Smart Grid - Load Altering Attacks - False Data Injection Attacks - Mitigation Approaches - Standards **(9)**

RENEWABLE ENERGY, POWER ELECTRONIC INTERFACE AND STORAGE (QUALITATIVE TREATMENT ONLY)

Renewable Energy Sources - Sustainable Energy Options for the Smart Grid - Variability Issues Associated with Sustainable Energy Technology - Demand Response Issues.

Power Electronics in the Smart Grid - Fault Current Limiting - Power Quality Issues - Shunt Compensation: STATCOM - Active Filtering - Shunt Compensator with Energy Storage - Power Electronics for Bulk Power Flows : FACTS - HVDC systems.

Energy Storage Technologies : Batteries - Flow Battery - Fuel Cell and Hydrogen Electrolyser SMES - Super Capacitors. **(9)**

SMART GRID PATHWAYS TO DESIGN AND CASE STUDIES

Introduction to Smart Grid Pathway Design - Barriers and Solutions to Smart Grid Development - Automation at Generation, Transmission, Distribution and End User Level.

Demonstration Projects - Advanced Metering - Sample Microgrid Test Bed Environment - Case Study for Renewable Energy Resource Integation : Description of Smart Grid Activity - Approach for Smart Grid Application - Benchmarking - Economics and Market Opertions - Pricing and Energy Consumption Scheduling - Wheeling Prices - Sample Design. **(9)**

TOTAL : 45

TEXT BOOK

1. James Momoh, “Smart Grid - Fundamentals of Design and Analysis” IEEE Press, John Wiley & Sons, INC., New Jersey, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama," Smart Grid: Technology and Applications", John Wiley & Sons Ltd., West Sussex, 2012.

REFERENCE BOOKS

1. Ali Keyhani, “Design of Smart Power Grid Renewable Energy System” IEEE Press, John Wiley & Sons, INC, New Jersey, 2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response" Taylor and Francis Group, CRC Press, 2009.
3. Stuart Borlase, “Smart Grids : Infrastructure, Technology and Solutions” Taylor and Francis Group, CRC Press, 2013.
4. Stephen F. Bush, “Smart Grid : Communication - Enabled Intelligence for the Electric Power Grid” Wiley - IEEE Press, 2014
5. Uslar, "Standardization in Smart Grids: Introduction to IT related Methodologies, Architectures and Standards", Wiley Publication, 2013.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X							
CO2	X	X	X	X	X	X	X	X	X	X		
CO3	X	X	X	X	X	X	X	X	X	X	X	
CO4	X	X	X	X	X	X	X	X	X	X	X	

13ER19 - SPECIAL ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To make the students understand the concepts and working principles of special electrical machines and their applications in the modern industries.

COURSE OUTCOMES

CO1 : *At the end of this course, the students will have clear knowledge about the principle and operation of special electrical machines.*

CO2 : *They would be able to select motor depending on their requirement or any particular application.*

CO3 : *To acquire knowledge in the area of stepper motor, reluctance motor and brushless DC motors and their applications.*

STEPPER MOTORS

Introduction-comparison with servo motors-types and construction features - method of operation - mechanism of torque production- characteristics of stepper motors - half stepping and the required switching sequence -open loop and closed loop control of VR stepper motor - single phase stepping motor-driver circuit for stepper motors: unipolar and bipolar driver circuits- ratings and applications. **(9)**

RELUCTANCE MOTORS

Introduction - general - types of synchronous motors - reluctance - motors - definitions - construction - polyphase and split phase reluctance motors - capacitor type reluctance motors - hysteresis motors - construction - polyphase - capacitor type and shaded pole hysteresis motors - universal motors - universal motors - application and torque - characteristics - essential parts of universal motors. **(9)**

BRUSHLESS DC MOTORS

Introduction-types and constructional features-principal of operation- unidirectional and bidirectional brushless DC motors-sensing and switching logic scheme-drive and power circuits-applications. **(9)**

SWITCHED RELUCTANCE MOTORS (SRM)

Introduction - principle of operation of Switched Reluctance Motors (SRM)-comparison between SRM and conventional reluctance motors-design aspects of stator and rotor pole arcs-derivation of torque expression-torque -speed characteristics-power converters for SRM-driver circuits-applications-switched reluctance generator. **(9)**

LINEAR ELECTRICAL MACHINES

Linear machines - basic difference between Linear Electrical Machines (LEMS) and rotating - machine - classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linear levitation machines - Machines used in CNC, Robotics and Aviation. **(9)**

TOTAL : 45

TEXT BOOK

1. K.Venkataratnam, "Special Electrical machines" Universities Press, First Edition 2008.

REFERENCE BOOKS

1. T.J.E. Miller, "Electronic Control of Switched Reluctance Machines" Newnes Publishers, 2004.
2. S.A.Nasar, "Electric Machines and Electro mechanics" Schaum Outlines Series, Second Edition,2006.
3. R.Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications" Industrial Electronics Series, CRC Press, New York, 2002.
4. R.Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives" CRC Press, New York, 2009.
5. S.A.Nasar, I.Boldea, "Linear Motion Electric Machines" John Wiley & Sons Inc, New York, 1976.
6. Cyril G. Veinott, "Fractional and Sub fractional Horsepower Electric Motors: Available Types, Basic Operating Principles, Selection, and Maintenance" McGraw Hill Publishers, Singapore, 2002.

Mapping of Course Outcomes (COs) and Programme Outcomes (POs)

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X										
CO2				X		X	X	X	X	X		
CO3					X	X	X	X	X	X	X	

13ER20 - VIRTUAL INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

The students can implement the programming basics on completion of this course.To study the programming techniques in virtual instrumentation and the hardware features of interfacing.

COURSE OUTCOMES

CO1 : *The students can develop programmes in VI for any application.*

CO2 : *The interface of data acquisition card with the system could be implemented to industrial problems.*

CO3 : *The knowledge in the area of Industrial Communication, Image Acquisition and motion control could be implemented for real time applications.*

INTRODUCTION TO VI AND DATA FLOW TECHNIQUES

General functional description of a digital instrument, block diagram of a virtual instrument, computers in instrumentation; historical perspective; advantages of virtual instruments (VI) and graphical programming; VI for test, measurement and control, development of virtual instrument using GUI. Software environment; palettes; data types and colour coding; editing, debugging and running a vi; data-flow programming; modular programming, loops, local and global variables; arrays; clusters. **(9)**

PROGRAMMING TECHNIQUES

Plotting data; making decisions in a VI; string; File I/O, semaphores, TCP/IP, shared variables, data publishing, state machines. **(9)**

DATA ACQUISITION BASICS

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements. **(9)**

VI CHASSIS REQUIREMENTS, COMMON INSTRUMENT INTERFACES

Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI. **(9)**

VI TOOLSETS, DISTRIBUTED I/O MODULES. APPLICATION OF VIRTUAL INSTRUMENTATION

Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. **(9)**

TOTAL : 45

TEXT BOOKS

1. Gary W Johnson, Richard Jennings, "LabVIEW Graphical Programming", Third Edition, McGraw Hill, New York, 2001.
2. Jovitha Jerome, "Virtual Instrumentation Using Lab VIEW" Prentice Hall of india Publishers, 2009.

REFERENCES

1. LabVIEW: Basics I & Basics II, National Instruments, 2006.
2. LabVIEW 2009:Authors and Organization:Robert Bishop, University ofTexas at Austin Publisher: Prentice Hall.
3. Sanjay Gupta and Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw-Hill, First Edition, 2005.
4. Lisa K Wells and Jeffrey Travis, "LabVIEW for Everyone", Prentice Hall, New Jersey, 1997.
5. Kevin James, "PC Interfacing and Data Acquisition Techniques for Measurement, instrumentation and Control", Newnes, 2000.
6. www.ni.com
7. www.ltrpub.com

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	X	X	X	X	X	X	X	X	X	X	X	
CO2	X	X	X	X	X	X	X	X	X	X	X	
CO3	X	X	X	X	X	X	X	X	X	X	X	X

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

GOLDEN JUBILEE

(1956 - 2006)

Department of Electrical and Electronics Engineering

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
(FULL TIME)

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

(For the students admitted during 2013-2014 onwards)

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