COURSES AND EVALUATION SCHEME

B.TechElectrical Engineering

BOS 2018

G.B.Pant Institute of Engineering and Technology, Pauri-Garhwal (Uttarakhand), 246194

COURSES AND EVALUATION SCHEME

YEAR I, SEMESTER I
(B.Tech. Electrical Engineering)
(Effective from session: 2018-19)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
THEORY											
1.	TBS111	Chemistry	3	1	0	40	40	80	120	200	4
2.	TBS112	Mathematics-I	3	1	0	40	40	80	120	200	4
3.	TES111	Programming for Problem Solving	3	1	0	40	40	80	120	200	4
4.	TMC111	Environmental Science*	2	0	0	20	20	40	60	100	0
PRACTICAL											
5.	PBS111	Chemistry Lab	0	0	2	10	15	25	25	50	1
6.	PES111	Programming for Problem Solving Lab	0	0	2	10	15	25	25	50	1
7.	PES112	Workshop/Manufacturing Practices	1	0	4	30	45	75	75	150	3
8.	GPP 111	General Proficiency*	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**12**	**3**	**8**	**190**	**265**	**455**	**545**	**1000**	**17**

COURSES AND EVALUATION SCHEME

YEAR I, SEMESTER II

(B. Tech. Electrical Engineering)

(Effective from session: 2018-19)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
THEORY											
1.	TBS124	Physics	3	1	0	40	40	80	120	200	4
2.	TBS125	Mathematics-II	3	1	0	40	40	80	120	200	4
3.	TES123	Basic Electrical Engg	3	1	0	40	40	80	120	200	4
4.	THS121	English	2	0	2	30	30	60	90	150	3
PRACTICAL											
5.	PBS 124	Physics Lab	0	0	2	10	15	25	25	50	1
6.	PES123	Basic Electrical Engg Lab	0	0	2	10	15	25	25	50	1
7.	PES124	Engg Graphics & Design	1	0	4	30	45	75	75	150	3
8.	GPP 121	General Proficiency*	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**12**	**3**	**10**	**200**	**275**	**475**	**575**	**1050**	**20**

COURSES AND EVALUATION SCHEME

YEAR II, SEMESTER III
(B. Tech. Electrical Engineering)
(Effective from session: 2019-20)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	TEE 231	Analog Electronics	3	1	0	40	40	80	120	200	4
2.	TEE 232	Electric Machine-I	3	1	0	40	40	80	120	200	4
3.	TEE 233	Electrical Circuit Analysis	3	1	0	40	40	80	120	200	4
4.	TEE 234	Electromagnetic Field	3	1	0	40	40	80	120	200	4
5.	TEE 235	Signals and Systems	3	1	0	40	40	80	120	200	4
6.	TES 234	Engg. Mechanics	3	1	0	40	40	80	120	200	4
PRACTICALS											
7.	PEE 231	Analog Electronics Lab	0	0	2	15	10	25	25	50	1
8.	PEE 232	Electrical Machine-I Lab	0	0	2	15	10	25	25	50	1
9.	GPP 231	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**18**	**6**	**4**	**270**	**310**	**580**	**770**	**1350**	**26**

COURSES AND EVALUATION SCHEME

YEAR II, SEMESTER IV

(B. Tech. Electrical Engineering)

(Effective from session: 2019-20)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	TEE 241	Digital Electronics	3	1	0	40	40	80	120	200	4
2.	TEE 242	Electrical Machine-II	3	1	0	40	40	80	120	200	4
3.	TEE 243	Microprocessor	3	1	0	40	40	80	120	200	4
4.	TEE 244	Measurement & Instrumentation	3	1	0	40	40	80	120	200	4
5.	TBS 241	Mathematics-III (Probability & Statistics)	3	1	0	40	40	80	120	200	4
6.	TMC 241	Constitution of India*	2	0	0	20	20	40	60	100	0
PRACTICALS											
7.	PEE 241	Digital Electronics Lab	0	0	2	15	10	25	25	50	1
8.	PEE 242	Electrical Machines-II Lab	0	0	2	15	10	25	25	50	1
9.	PEE 243	Microprocessor Lab	0	0	2	15	10	25	25	50	1
10.	PEE 244	Measurement & Instrumentation Lab	0	0	2	15	10	25	25	50	1
11.	GPP 241	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**17**	**5**	**8**	**280**	**310**	**590**	**760**	**1350**	**24**

COURSES AND EVALUATION SCHEME

YEAR III, SEMESTER V
(B. Tech. Electrical Engineering)
(Effective from session: 2020-21)

S. No.	COURSECODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	TEE 351	Power System-I (Apparatus & Modeling)	3	1	0	40	40	80	120	200	4
2.	TEE 352	Control System	3	1	0	40	40	80	120	200	4
3.	TEE 353	Power Electronics	3	1	0	40	40	80	120	200	4
4.	EEE 31X	Program Elective-I	3	1	0	40	40	80	120	200	4
5.	TOE XY	Open Elective-I	3	0	0	30	30	60	90	150	3
6.	THS 352	Principle of Management	3	0	0	30	30	60	90	150	3
PRACTICALS											
7.	PEE 351	Power System-I Lab	0	0	2	15	10	25	25	50	1
8.	PEE 352	Control System Lab	0	0	2	15	10	25	25	50	1
9.	PEE 353	Power Electronics Lab	0	0	2	15	10	25	25	50	1
10.	PEE 354	Summer Industry Internship	0	0	2	25	25	50	0	50	1
11.	GPP 351	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**18**	**4**	**8**	**290**	**325**	**615**	**735**	**1350**	**26**

List of Program Elective – I
EEE 311: Electric Machine Design
EEE 312: Electrical Energy Conservation and Auditing
EEE 313: High Voltage Engg
EEE 314: Electromagnetic Waves

COURSES AND EVALUATION SCHEME

YEAR III, SEMESTER VI

(B. Tech. Electrical Engineering)

(Effective from session: 2020-21)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	TEE 361	Power System-II (Operation & Control)	3	1	0	40	40	80	120	200	4
2.	EEE 32X	Program Elective-II	3	1	0	40	40	80	120	200	4
3.	EEE 33X	Program Elective-III	3	1	0	40	40	80	120	200	4
4.	TOE XY	Open Elective-II	3	0	0	30	30	60	90	150	3
5.	THS 362	Engineering Economics	3	0	0	30	30	60	90	150	3
6.	TMC 361	Essence of Indian Traditional Knowledge*	2	0	0	20	20	40	60	100	0
PRACTICALS											
7.	PEE 361	Power System-II Lab	0	0	2	15	10	25	25	50	1
8.	PEE 362	Electronics Design Lab	1	0	4	30	45	75	75	150	3
9.	PEE-363	Summer Industry Internship	0	0	2	25	25	50	0	50	1
10	GPP 361	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**18**	**3**	**8**	**270**	**330**	**600**	**700**	**1300**	**23**

List of Program Elective – II
EEE 321: Line Commutated and Active Rectifiers
EEE 322: Electrical Drives
EEE 323: Industrial Electrical Systems
EEE 324: Digital Control Systems

List of Program Elective – III
EEE 331: Digital Signal Processing
EEE 332: Computer Architecture
EEE 333: Computational Electromagnetics
EEE 334: Control Systems Design

COURSES AND EVALUATION SCHEME

YEAR IV, SEMESTER VII
(B. Tech. Electrical Engineering)
(Effective from session: 2021-22)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	EEE 44X	Program Elective-IV	3	1	0	40	40	80	120	200	4
2.	EEE 45X	Program Elective-V	3	1	0	40	40	80	120	200	4
3.	TOEXY	Open Elective-III	3	0	0	30	30	60	90	150	3
4.	TOE XY	Open Elective-IV	3	0	0	30	30	60	90	150	3
5.	THS 472	Project Management & Entrepreneurship	3	0	0	30	30	60	90	150	3
PRACTICALS											
6.	PEE 471	Project Stage-I	0	0	8	40	40	80	120	200	4
7.	PEE 472	Summer Industry Internship	0	0	2	10	15	25	25	50	1
8.	GPP 471	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**15**	**2**	**10**	**220**	**275**	**495**	**655**	**1150**	**22**

List of Program Elective – IV
EEE 441: Wind and Solar Energy Systems
EEE 442: Electrical and Hybrid Vehicles
EEE 443: Power System Protection
EEE 444: Intelligent Systems

List of Program Elective – V
EEE 451: HVDC Transmission Systems
EEE 452: Power Quality and FACTS
EEE 453: Power System Dynamics and Control
EEE 454: Machine Modelling

COURSES AND EVALUATION SCHEME

YEAR IV, SEMESTER VIII
(B. Tech. Electrical Engineering)
(Effective from session: 2021-22)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	Credit
			L	T	P	CT	TA	Total			
Theory Subject											
1.	EEE 46X	Program Elective-VI	3	1	0	40	40	80	120	200	4
2.	TOE XY	Open Elective-V	3	0	0	30	30	60	90	150	3
3.	TOE XY	Open Elective-VI	3	0	0	30	30	60	90	150	3
PRACTICALS											
4.	PEE 481	Project Stage-II	0	0	16	80	80	160	240	400	8
5.	GPP 481	General Proficiency*	0	0	0	0	50	50	0	50	0
		Semester Total	**9**	**1**	**16**	**180**	**230**	**410**	**540**	**950**	**18**

List of Program Elective – VI
EEE 461: Advanced Electric Drives
EEE 462: Advanced Power Electronics
EEE 463: Power System Transients
EEE 464: Biomedical Instrumentation

List of Open Elective Subjects

1. Electrical Machine
2. Non-Conventional Energy System
3. Digital Control System
4. Power Station Practice
5. Modern Control System
6. Electrical Material
7. Intelligent System
8. Bio Medical Signal Processing
9. Advanced Instrumentation
10. Industrial Process Control

TBS-111: CHEMISTRY

L T P
3 1 0

Contents

Module 1: Atomic and molecular structure (12 hours)
Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations.Molecular orbitals of diatomic molecules and plots of the multi-centre orbitals.Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity.Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.Band structure of solids and the role of doping on band structures.

Module 2: Spectroscopic techniques and applications (8 hours)
Principles of spectroscopy and selection rules.Electronic spectroscopy.Fluorescence and its applications in medicine.Vibrational and rotational spectroscopy of diatomic molecules.Applications.Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques.Diffraction and scattering.

Module 3: Intermolecular forces and potential energy surfaces (4 hours)
Ionic, dipolar and van Der Waals interactions.Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

Module 4: Use of free energy in chemical equilibria (6 hours)
Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies.Free energy and emf.Cell potentials, the Nernst equation and applications.Acid base, oxidation reduction and solubility equilibria.Water chemistry.Corrosion.Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 5: Periodic properties (4 hours)
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

Module 6: Stereochemistry (4 hours)
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

Module 7: Organic reactions and synthesis of a drug molecule (4 hours)
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings.Synthesis of a commonly used drug molecule.

Text / References:

1. B. H. Mahan, “University chemistry”, Addison-Wesley Publishing Company, 1975.
2. M. J. Sienko and R. A. Plane, “Chemistry: Principles and Applications”, McGraw Hill International, 1974.
3. C. N. Banwell, “Fundamentals of Molecular Spectroscopy”, McGraw Hill Education, 1994.

Course Outcomes

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications.

Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.

Rationalise bulk properties and processes using thermodynamic considerations.

Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques

Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.

List major chemical reactions that are used in the synthesis of molecules.

TBS-112: MATHEMATICS – I

L T P
3 1 0

Contents

Module 1: Calculus (8 hours)
Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 2: Sequences and Series (7 hours)
Convergence of sequence and series, tests for convergence, power series, Taylor's series. Series for exponential, trigonometric and logarithmic functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 3: Multivariable Calculus: Differentiation (6 hours)
Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Module 4: Multivariable Calculus: Integration (7 hours)
Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.

Module 5: First Order Ordinary Differential Equations (3 hours)
Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 6: Ordinary Differential Equations of Higher Order (6 hours)
Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 7: Partial Differential Equations: First Order (3 hours)
First order partial differential equations, solutions of first order linear and non-linear PDEs.

Text / References:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", Pearson, 2002.
2. T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
3. B. V. Ramana, "Higher Engineering Mathematics", McGraw Hill, New Delhi, 2010.
4. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.
5. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2000.
6. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2006.

TES – 111: PROGRAMMING FOR PROBLEM SOLVING

L T P
3 10

Unit 1: Introduction to Programming (3 hours)
Introduction to the idea of algorithm; Introduction to Programming (Flow chart/pseudocode); the compilation process, object code and executables, Variables (including data types), Mapping of variables to memory locations, Syntax and logical error

Unit 2: Arithmetic expressions, precedence, Conditional Branching and Loops (10 hours)
Writing and evaluation of conditionals and consequent branching, Iteration and loops.

Unit 3: Arrays (6 hours)
Arrays (1-D, 2-D), Character arrays and Strings.

Unit 4: Basic Algorithms (6 hours)
Searching: Linear and Binary, Basic Sorting Algorithms, Finding roots of equations (two algorithms)

Unit 5: Function and Recursion (10 hours)
Functions (including using built in libraries), Parameter passing, Call by value, Passing Arrays to functions, Call by reference. Introduction to Recursion; Base condition, example programs such as Factorial, Fibonacci series, Quick sort, Ackerman function etc.

Unit 6: Structures and Pointers (5 hours)
Structures, typedef, Array of structures; notional introduction to pointers including self-referential structures.

Text / References:

1. B. Gottfried, “Programming with C”, McGraw-Hill Professional, 1996.
2. E. Balagurusamy, “Programming in ANSI C”, McGraw-Hill Education, 2008.
3. B. W. Kernighan and D. M. Ritchie, “The C Programming Language”, Prentice Hall of India, 1990.

Course Outcomes: The course will enable the students.

To formulate simple algorithms for arithmetic and logical problems.To translate the algorithms to programs (in C language).

To test and execute the programs and correct syntax and logicalerrors.To implement conditional branching, iteration and recursion.

To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

To use arrays, pointers and structures to formulate algorithms and programs.

To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

TMC-111: ENVIRONMENTAL SCIENCE

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2 1 0

Unit-I

Natural Resources: Renewable and Non-renewable Resources: Naturalresources and associated problems.

Forest Resources: Use and over-exploitation, deforestation, case studies. Timberextraction, mining, dams and their effects on forest and tribal people.

Water Resources: Use and over-utilization of surface and ground water, floods, drought,conflicts over water, dams-benefits and problems.

Mineral Resources: Use and exploitation, environmental effects of extracting and usingmineral resources, case studies.

Food Resources: World food problems, changes caused by agriculture and over-grazing,effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Energy Resources: Growing energy needs renewable and non renewable energy sourcesuse of alternate energy sources, case studies.

Land Resources: Land as a resource, land degradation, man induced landslides, soilerosion and desertification, role of an individual in conservation of natural resources, equitableuse of resources for sustainable lifestyles.

Unit-II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem,producers, consumers and decomposers, energy flow in the ecosystem, ecological succession,food chains, food webs and ecological pyramids, introduction, types, characteristic features,structure and function of the Forest ecosystem; Grassland ecosystem; Desert ecosystem,Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit-III

Biodiversity and its Conservation: Introduction – Definition: genetic, speciesand ecosystem diversity, Biogeographical classification of India, Value of biodiversity,consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity atglobal, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity,Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered andendemic species of India, Conservation of biodiversity: In-situ and Ex-situconservationofbiodiversity.

Unit-IV

Environmental Pollution & Social Issues: Definition, cause, effects andcontrol measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution,thermal pollution, nuclear hazards, disaster management: floods, earthquake, cyclone andlandslides, from unsustainable to sustainable development, urban problems related to energy,water conservation, rain water harvesting, watershed management, environmental ethics:issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion,nuclear accidents and holocaust, case studies, wasteland reclamation, consumerism and wasteproducts.

References:

1. M Ajni Reddy, Text book of environmental Science, BS Publication, Hyderabad
2. Environmental Studies by Daniel, Wiley India
3. Environmental Studies by ErachBharucha, University Press.
4. Fundamental of Ecology, E.P.Odum, Cengage Learning.

PBS – 111: CHEMISTRY LAB

L T P
0 0 2

Choice of 10-12 experiments from the following

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscometers to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatine sols and/or coagulation of the white part of egg

Laboratory Outcomes

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:

Estimate rate constants of reactions from concentration of reactants/products as a function of time

Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc

Synthesize a small drug molecule and analyse a salt sample

PES- 111 PROGRAMMING FOR PROBLEM SOLVING LAB

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0 0 2

Tutorial and Lab combined: (total 4 contact hours per week) (outline of topics)

Tutorial 1: Problem solving using computers: Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions: Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions: Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops: Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting: Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings, memory structure: Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value: Lab 7: Simple functions

Tutorial 8 & 9: Numerical methods (Root finding, numerical differentiation, numerical integration):

Lab 8 and 9: Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls: Lab 10: Recursive functions

Tutorial 11: Pointers explained Lab 11: Implementing and accessing array of structures

Tutorial 12: File handling: Lab 12: File operations

PES- 112 WORKSHOP/MANUFACTURING PRACTICES

L T P
1 0 4

Manufacturing is fundamental to the development of any engineering product. The course on Engineering Workshop Practice is intended to expose engineering students to different types of manufacturing/ fabrication processes, dealing with different materials such as metals, ceramics, plastics, wood, glass etc. While the actual practice of fabrication techniques is given more weightage, some lectures and video clips available on different methods of manufacturing are also included.

Lectures & videos: (10 hours)

1. Manufacturing Methods-casting, forming, machining, joining, advanced manufacturing methods	(3 lectures)
2. CNC machining, Additive manufacturing	(1 lecture)
3. Fitting operations & power tools	(1 lecture)
4. Electrical & Electronics	(1 lecture)
5. Carpentry	(1 lecture)
6. Plastic moulding, glass cutting	(1 lecture)
7. Metal casting	(1 lecture)
8. Welding (arc welding & gas welding), brazing	(1 lecture)

Workshop Practice: (60 hours)

1. Machine shop	-	10 hours
2. Fitting shop	-	8 hours
3. Carpentry	-	6 hours
4. Electrical & Electronics	-	8 hours
5. Welding shop	-	8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting	-	8 hours
7. Smithy	-	6 hours
8. Plastic moulding &Glass Cutting	-	6 hours

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understanding different manufacturing techniques and their relative advantages/ disadvantages with respect to different applications.

Selection of a suitable technique for meeting a specific fabrication need.

Acquire a minimum practical skill with respect to the different manufacturing methods and develop the confidence to design & fabricate small components for their project work and also to participate in various national and international technical competitions.

Introduction to different manufacturing methods in different fields of engineering.Practical exposure to different fabrication techniques.

Creation of simple components using different materials.

TBS – 124: PHYSICS

L T P
3 1 0

Module 1: Waves (3 hours)

Mechanical and electrical simple harmonic oscillators, damped harmonic oscillator, forced mechanical and electrical oscillators, impedance, steady state motion of forced damped harmonic oscillator

Module 2: Non-dispersive transverse and longitudinal waves (4 hours)

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves

Module 3: Light and Optics (3 hours)

Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them

Module 4: Wave Optics (5 hours)

Huygens' principle, superposition of waves and interference of light by wavefront splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power

Module 5: Lasers (5 hours)

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO_2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity

Module 6: Introduction to Quantum Mechanics (5 hours)

Wave nature of Particles, Time-dependent and time-independent Schrodinger equation for wave function, Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle.

Module 7: Solution of Wave Equation(6 hours)

Solution of stationary-state Schrodinger equation for one dimensional problems–particle in a box, particle in attractive delta-function potential, square-well potential, linear harmonic oscillator.Scattering from a potential barrier and tunneling; related examples like alpha-decay, field-ionization and scanning tunneling microscope, tunneling in semiconductor structures. Three-dimensional problems: particle in three dimensional box and related examples.

Module 8: Introduction to Solids and Semiconductors.(9 hours)

Free electron theory of metals, Fermi level, density of states in 1, 2 and 3 dimensions, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

Types of electronic materials: metals, semiconductors, and insulators. Intrinsic and extrinsicsemiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p -n junction.

Text / References:

1. I. G. Main, “Vibrations and waves in physics”, Cambridge University Press, 1993.
2. H. J. Pain, “The physics of vibrations and waves”, Wiley, 2006.
3. E. Hecht, “Optics”, Pearson Education, 2008.
4. A. Ghatak, “Optics”, McGraw Hill Education, 2012.
5. O. Svelto, “Principles of Lasers”, Springer Science & Business Media, 2010.
6. D. J. Griffiths, “Quantum mechanics”, Pearson Education, 2014.
7. R. Robinett, “Quantum Mechanics”, OUP Oxford, 2006.
8. D. McQuarrie, “Quantum Chemistry”, University Science Books, 2007.
9. D. A. Neamen, “Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago, 1997.
10. E.S. Yang, “Microelectronic Devices”, McGraw Hill, Singapore, 1988.
11. B.G. Streetman, “Solid State Electronic Devices”, Prentice Hall of India, 1995.

TBS-125: MATHEMATICS-II

L T P
3 1 0

Module 1: Matrices (10 hours)
Algebra of matrices, Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.

Module 2: Numerical Methods-I (10 hours)
Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Interpolation using Newton's forward and backward difference formulae. Central difference interpolation: Gauss's forward and backward formulae. Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

Module 3: Numerical Methods-II (10 hours)
Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge-Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Partial differential equations: Finite difference solution two dimensional Laplace equation and Poisson equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.

Module 4: Transform Calculus (10 hours)
Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method. Fourier transforms.

Text / References:

1. D. Poole, "Linear Algebra: A Modern Introduction", Brooks/Cole, 2005.
2. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2008.
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2010.
4. V. Krishnamurthy, V. P. Mainra and J. L. Arora, "An introduction to Linear Algebra", Affiliated East-West press, 2005.

TES-123: BASIC ELECTRICAL ENGINEERING

L T P
3 1 0

Module 1: DC Circuits (8 hours)
Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation.Superposition, Thevenin and Norton Theorems.Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)
Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)
Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)
Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters and Electrical Installations (12 hours)
DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.
Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Text / References:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
3. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
4. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
5. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes:

At the end of this course, students will demonstrate the ability

To understand and analyse basic electric and magnetic circuits.

To study the working principles of electrical machines and power converters.

To introduce the components of low-voltage electrical installations.

THS – 121: ENGLISH

L T P
3 1 0

Detailed contents

1. Vocabulary Building

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives,Synonyms, antonyms, and standard abbreviations.

2. Basic Writing Skills

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely

3. Identifying Common Errors in Writing

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

4. Nature and Style of sensible Writing

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

5. Writing Practices

Comprehension, Précis Writing, Essay Writing

6. Oral Communication

(This unit involves interactive practice sessions in Language Lab)

Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues Communication at Workplace, Interviews, Formal Presentations

Suggested Readings:

(i) Practical English Usage. Michael Swan. OUP. 1995.

(ii) Remedial English Grammar. F.T. Wood. Macmillan.2007

(iii) On Writing Well. William Zinsser. Harper Resource Book. 2001

(iv)Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.

(vi)Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Course Outcomes

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

PBS-124: PHYSICS LAB

L T P
0 0 2

1. To determine the wavelength of monochromatic light by Newton's ring.
2. To determine the wavelength of monochromatic light with the help of Fresnel's biprism.
3. To determine the focal length of two lenses by nodal slide and locate the position of cardinal points.
4. To determine the specific rotation of cane sugar solution using half shade polarimeter.
5. To determine the wavelength of spectral lines using plane transmission grating.
6. To determine the specific resistance of the material of given wire using Carey Foster's bridge.
7. To determine the variation of magnetic field along the axis of a current carrying coil and then to estimate the radius of the coil.
8. To verify Stefan's Law by electrical method.
9. To calibrate the given ammeter and voltmeter.
10. To study the Hall Effect and determine Hall coefficient, carnier density and mobility of a given semiconductor material using Hall-effect set up.
11. To determine energy bank gap of a given semiconductor material.
12. To determine E.C.E. of copper using Tangent or Helmholtz galvanometer.
13. To draw hysteresis curve of a given sample of ferromagnetic material and from this to determine magnetic susceptibility and permeability of the given specimen.
14. To determine the balistic constant of a ballistic galvanometer.
15. To determine the viscosity of a liquid.

PES-123: BASIC ELECTRICAL ENGG LAB

L T P
0 0 2

1. Verification of KCL and KVL.
2. Verification of Thevenin's and Norton's Theorems.
3. Verification of Maximum power transfer and Superposition theorems.
4. Measurement of power in a three phase circuit by two wattmeter method.
5. Measurement of efficiency of a single phase transformer by load test.
6. Determination of parameters and losses in a single phase transformer by OC and SC test.
7. Load characteristics of DC generator.
8. Speed control of dc shunt motor.
9. Study of running and reversing of a three phase induction motor.
10. Calibration of a single phase energy meter.

****Additional or any other experiment may be added based on contents of syllabi.

PES-124: ENGINEERING GRAPHICS LAB

L T P
1 0 4

All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software.

This course is designed to address:

to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

to prepare you to communicate effectively

to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

Proposed Syllabus

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Introduction to engineering design and its place in society

Exposure to the visual aspects of engineering design

Exposure to engineering graphics standards

Exposure to solid modelling

Exposure to computer-aided geometric design Exposure to creating working drawings

Exposure to engineering communication

TEE-231: ANALOG ELECTRONICS

L T P
3 1 0

Module 1: Diode circuits and BJT circuits (12 Hours)

P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

Structure and I- V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common- emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

Module 2: MOSFET circuits (8 Hours)

MOSFET structure and I-V characteristics.MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 3: Differential, multi-stage and operational amplifiers (8 Hours)

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 4: Linear applications of op-amp (8 Hours)

Idealized analysis of op-amp circuits. Inverting and non- inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.

Module 5: Nonlinear applications of op-amp (6 Hours)

Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators.Precision rectifier, peak detector.Monoshot.

Text/References:

1. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the characteristics of transistors.

Design and analyse various rectifier and amplifier circuits. Design sinusoidal and non-sinusoidal oscillators.

Understand the functioning of OP-AMP and design OP-AMP based circuits.

TEE-232: ELECTRIC MACHINE-I

L T P
3 1 0

Module 1: Magnetic fields and magnetic circuits (6 Hours)
Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

Module 2: Electromagnetic force and torque (9 Hours)
B-H curve of magnetic materials; flux- linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

Module 3: DC machines (8 Hours)
Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module 4: DC machine - motoring and generation (7 Hours)
Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Module 5: Transformers (12 Hours)
Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No- load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Text / References

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of magnetic circuits.

Understand the operation of dc machines.

Analyse the differences in operation of different dc machine configurations. Analyse single phase and three phase transformers circuits.

TEE- 233: ELECTRICAL CIRCUIT ANALYSIS

L T P
3 1 0

Module 1: Network Theorems (10 Hours)
Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem.Analysis with dependent current and voltage sources, Node and Mesh Analysis, Concept of duality and dual networks.

Module 2: Solution of First and Second order networks (8 Hours)
Solution of first and second order differential equations for Series and parallel R- L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Module 3: Sinusoidal steady state analysis (8 Hours)
Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.

Module 4: Electrical Circuit Analysis Using Laplace Transforms (8 Hours)
Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances

Module 5: Two Port Network and Network Functions (6 Hours)
Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

Text / References:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Apply network theorems for the analysis of electrical circuits.

Obtain the transient and steady-state response of electrical circuits.

Analyse circuits in the sinusoidal steady-state (single-phase and three-phase). Analyse two port circuit behavior.

TEE-234: ELECTROMAGNETIC FIELD

L T P
3 1 0

Module 1: **Review of Vector Calculus (6 hours)**
Vectoralgebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus-differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl;integraltheorems of vectors. Conversion of a vector from one coordinate system to an other.

Module 2: Static Electric Field and Static Magnetic Fields (12 Hours)
Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.
Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Module 3: Conductors, Dielectrics and Capacitance (6 Hours)
Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 4: Magnetic Forces, Materials and Inductance (6 Hours)
Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Module 5: Time Varying Fields, Maxwell's Equations and Electromagnetic Waves (12 Hours)
Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.
Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G.W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W.J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W.J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
7. E.G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
8. B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.

Course Outcomes:

At the end of the course, students will demonstrate the ability

To understand the basic laws of electromagnetism.

To obtain the electric and magnetic fields for simple configurations under static conditions.

To analyse time varying electric and magnetic fields.

To understand Maxwell's equation in different forms and different media.

To understand the propagation of EM waves.

This course shall have Lectures and Tutorials. Most of the students find difficult to visualize electric and magnetic fields. Instructors may demonstrate various simulation tools to visualize electric and magnetic fields in practical devices like transformers, transmission lines and machines.

TEE-235: SIGNALS AND SYSTEMS

L T P
3 1 0

Module 1: Introduction to Signals and Systems (3 hours)
Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time- limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module 2: Behaviour of continuous and discrete-time LTI systems (8 hours)
Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems.System representation through differential equations and difference equations.State-space Representation of systems.State-Space Analysis, Multi-input, multi-output representation.State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module 3: Fourier Transform(4 hours)
Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality.

Module 4:Laplace and z- Transforms (6 hours)
The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 5: Sampling and Reconstruction (4 hours)
The Sampling Theorem and its implications.Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects.Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
3. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of continuous time and discrete time systems.

TES- 234: ENGG MECHANICS

L T P
3 1 0

Module 1: Introduction to vectors and tensors and co-ordinate systems (5 hours)
Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indical notation; Symmetric and anti-symmetric tensors; Eigenvalues and Principal axes.

Module 2: Three-dimensional Rotation (4 hours)
Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors.

Module 3: Kinematics of Rigid Body (6 hours)
Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies (5 hours)
Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module 5: Free Body Diagram (1 hour)
Free body diagrams; Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (9 hours)
Examples and problems.General planar motions.General 3-D motions.Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment (5 hours)
Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams.

Module 8: Torsional Motion (2 hours)
Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Module 9: Friction (3 hours)
Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

Text / References:

1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011.
2. M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of co-ordinate systems. Analyse the three-dimensional motion.

Understand the concepts of rigid bodies.

PEE- 231: ANALOG ELECTRONICS LAB

L T P
0 0 2

1. To verify the configuration of various biasing techniques for BJTs.
2. To determine voltage gain output impedance and output power of a Darlington pair compound amplifier.
3. To determine “h” parameters of a PNP transistor in common emitter mode.
4. To determine the frequency response of an IFT amplifier.
5. To determine voltage gain and plot the frequency response of a FET amplifier in common source mode.
6. To study the effect of negative feedback on voltage gain & bandwidth in a two stage amplifier.
7. To determine frequency of a Hartley Oscillator circuit with change in the capacitor of the tank circuit.
8. To determine frequency and wave shape of a Colpitt’s oscillator circuit.
9. To determine frequency and wave shape of a crystal oscillator circuit.
10. To determine frequency and wave shape of a phase shift oscillator circuit.
11. To determine voltage gain and plot the frequency response of a single stage, two stage RC coupled and direct coupled amplifiers.

****Additional or any other experiment may be added based on contents of syllabi.

PEE- 232: ELECTRICAL MACHINE-I LAB

L T P
0 0 2

1. To obtain magnetization characteristics of a dc shunt generator.
2. To obtain load characteristics of a dc shunt generator and compound generator (a) Cumulatively compounded (b) Differentially compounded.
3. To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
5. To obtain performance curves of DC shunt motor.
6. To obtain performance curves of DC series motor.
7. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control.
8. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
9. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
10. To obtain 3-phase to 2-phase conversion by Scott connection.

****Additional or any other experiment may be added based on contents of syllabi.

TEE-241: DIGITAL ELECTRONICS

L T P
3 1 0

Module 1: Fundamentals of Digital Systems and logicfamilies (7Hours)
Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples ofICgates, number systems-binary, signed binary, octal hexadecimal number, binaryarithmeticone's and two's complements arithmetic, codes, error detecting and correctingcodes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-statelogic.

Module 2: Combinational DigitalCircuits (7Hours)
Standard representation for logic functions, K-map representation, simplification oflogicfunctions using K-map, minimization of logical functions. Don't care conditions, Multiplexer,De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder,serialadder, ALU, elementary ALU design, popular MSI chips, digital comparator,paritychecker/generator, code converters, priority encoders, decoders/drivers for display devices,Q-M method of functionrealization.

Module 3: Sequential circuits and systems (7Hours)
A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and typesflipflops,applicationsofflipflops,shiftregisters,applicationsofshiftregisters,serialtoparallel converter, parallel to serial converter, ring counter, sequence generator,ripple(Asynchronous) counters, synchronous counters, counters design using flip flops,specialcounter IC's, asynchronous sequential counters, applications of counters.

Module 4: A/D and D/A Converters (7Hours)
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/Aconverter,specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit,analog to digital converters: quantization and encoding, parallel comparator A/Dconverter,successive approximation A/D converter, counting A/D converter, dual slope A/Dconverter,A/Dconverterusingvoltagetofrequencyandvoltagetotimeconversion,specificationsofA/Dconverters, example of A/D converterICs.

Module 5: Semiconductor memories and Programmable logic devices. (7Hours)
Memory organization and operation, expanding memory size, classification andcharacteristicsof memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Text/References:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand working of logic families and logic gates.

Design and implement Combinational and Sequential logiccircuits.

Understand the process of Analog to Digital conversion and Digital to Analog conversion.

TEE-242: ELECTRICAL MACHINES-II

L T P
3 1 0

Module 1: Fundamentals of AC machine windings (8 Hours)
Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Module 2: Pulsating and revolving magnetic fields (4 Hours)
Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Module 3: Induction Machines (12 Hours)
Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque.Equivalent circuit.Phasor Diagram, Losses and Efficiency.Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors, Generator operation, Self-excitation. Doubly-Fed Induction Machines.

Module 4: Single-phase induction motors (6 Hours)
Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Module 5: Synchronous machines (10 Hours)
Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves.Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics.Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of rotating magnetic fields. Understand the operation of ac machines.

Analyse performance characteristics of ac machines.

TEE-243: MICROPROCESSOR

L T P
3 1 0

Module 1: Fundamentals of Microprocessors: (7 Hours)
Fundamentals of Microprocessor Architecture.8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers.Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.Overview of the 8051 family.

Module 2: The 8051 Architecture (8 Hours)
Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

Module 3: Instruction Set and Programming (8 Hours)
Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers.Programming and debugging tools.

Module 4: Memory and I/O Interfacing (6 Hours)
Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, memory devices.

Module 5: External Communication Interface and Applications (6 Hours)
Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.
LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Text / References:

1. M .A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning,2004.
3. R. Kamal, “Embedded System”, McGraw Hill Education,2009.
4. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996
5. D.A. Patterson and J.H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013.
6. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Do assembly language programming.

Do interfacing design of peripherals like I/O, A/D, D/A, timer etc. Develop systems using different microcontrollers.

TEE-244: MEASUREMENT & INSTRUMENTATION

L T P
3 1 0

Unit –1

Philosophy Of Measurement: Methods of Measurement, Measurement System**,** Classification of instrument system, Characteristics of instruments & measurement system**,** Errors in measurement & its analysis, Standards.

Analog Measurement of Electrical Quantities: Electro-dynamic, Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters, Electro-dynamic Wattmeter, Three Phase Wattmeter, Power in three phase system , errors & remedies in wattmeter and energy meter.

Unit –2

Instrument Transformers: Theory, construction, characteristics and their application of current and potential transformers. Ratio and phase angle errors and their minimization, Introduction to measurement of speed, frequency and power factor.

Unit –3

Measurement of R,L,C Parameters: Different methods of measuring low, medium and high resistances**,** measurement of inductance & capacitance with the help of Wheatstone, Kelvin, Maxwell, Hay's, Anderson, Owen, Heaviside, Campbell, Schering, Wien bridges; Bridge sensitivity; Wagner Earthing Device; Q Meter.

Unit –4

AC Potentiometer: Polar type & Co-ordinate type AC potentiometers, application of AC Potentiometers in electrical measurement.

Magnetic Measurement: Ballistic Galvanometer, **f**lux meter**,** determination of hysteresis loop, measurement of iron losses**.**

Unit –5

Digital Measurement of Electrical Quantities: Concept of digital measurement, block diagram, Study of digital voltmeter, frequency meter, Power Analyzer and Harmonics Analyzer; Electronic Multimeter.

Cathode Ray Oscilloscope : Basic CRO circuit (Block Diagram),Cathode ray tube (CRT) & its components **, a**pplication of CRO in measurement, Lissajous Pattern; Dual Trace & Dual Beam Oscilloscopes.

Books:

1. E. W. Golding & F.C. Widdis, “Electrical Measurement & Measuring Instrument”, A.W. Wheeler& Co. Pvt. Ltd. India.
2. A. K. Sawhney, “Electrical & Electronic Measurement & Instrument”, Dhanpat Rai & Sons, India.
3. Forest K. Harries, “Electrical Measurement”, Willey Eastern Pvt. Ltd. India.
4. W. D. Cooper, “Electronic Instrument & Measurement Technique”, Prentice Hall International

TBS 241: MATHEMATICS – III (PROBABILITY & STATISTICS)

L T P
3 1 0

Module 1: Basic Probability (12 hours)

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.

Module 2: Continuous Probability Distributions (4 hours)

Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Module 3: Bivariate Distributions (4 hours)

Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Module 4: Basic Statistics (8 hours)

Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Module 5: Applied Statistics (8 hours)

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Module 6: Small samples (4 hours)

Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.

Text / References:

1. E. Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability Theory”, Universal Book Stall, 2003.
3. S. Ross, “A First Course in Probability”, Pearson Education India, 2002.
4. W. Feller, “An Introduction to Probability Theory and its Applications”, Vol. 1, Wiley, 1968.
5. N.P. Bali and M. Goyal, “A text book of Engineering Mathematics”, Laxmi Publications, 2010.
6. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 2000.
7. T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

TMC-241: CONSTITUTION OF INDIA

L T P
2 0 0

Course content

Meaning of the constitution law and constitutionalism

Historical perspective of the Constitution of India

Salient features and characteristics of the Constitution of India

Scheme of the fundamental rights

The scheme of the Fundamental Duties and its legal status

The Directive Principles of State Policy – Its importance and implementation

Federal structure and distribution of legislative and financial powers between the Union and the States

Parliamentary Form of Government in India – The constitution powers and status of the President of India

Amendment of the Constitutional Powers and Procedure

The historical perspectives of the constitutional amendments in India

Emergency Provisions : National Emergency, President Rule, Financial Emergency

Local Self Government – Constitutional Scheme in India

Scheme of the Fundamental Right to Equality

Scheme of the Fundamental Right to certain Freedom under Article 19

Scope of the Right to Life and Personal Liberty under Article 21.

PEE – 241: DIGITAL ELECTRONICS LAB

L T P
0 0 2

1. Bread-board implementation of various flip-flops.
2. Bread-board implementation of counters & shift registers.
3. Determination of Delay time and NAND, NOR, Ex-OR, AND & OR Gates.
4. Experiments with clocked Flip-Flop.
5. Design of Counters.
6. Implementation of Arithmetic algorithms.
7. Bread Board implementation of Adder/Subtractor (Half, Full)
8. Transfer characteristics of TTL inverters & TTL Schmitt Trigger inverter.
9. Transfer characteristics of CMOS inverters series and CD40 series and
10. Estimation of Gate delay of CD40 series CMOS inverter.
11. Mono-shotmulti-vibrators using 74121 and 74123.
12. Clock circuit realization using 555 and CMOS inverter and quartz crystal.
13. Demultiplexer / Decoder operation using IC-74138.
14. To verify experimentally output of A/D and D/A converters.

****Additional or any other experiment may be added based on contents of syllabi.

PEE – 242: ELECTRICAL MACHINES - II LAB

L T P
0 0 2

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor.
2. To obtain torque-slip characteristic of three phase squirrel cage induction motor:
3. To perform no load and blocked rotor tests on a single phase induction motor.
4. To perform speed control of three phase slip ring induction motor by varying rotor resistance.
5. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation by EMF method and MMF method.
6. To obtain V-curves and inverted V-curves of a three phase synchronous motor.
7. To determine $X_d$and X_q of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve.
8. To study synchronization of an alternator with the infinite bus by using:

(i) dark lamp method, (ii) two bright and one dark lamp method

****Additional or any other experiment may be added based on contents of syllabi.

PEE – 243: MICROPROCESSOR LAB

L T P
0 0 2

A. Programming based Experiments (8085/8086 μP)

1. To perform the addition/ subtraction of two 8-bit numbers.
2. To perform the addition/ subtraction of two digit BCD numbers.
3. To perform multiplication/ division of given numbers.
4. To find the sum of a series of numbers.
5. To create a table of 5.

B. Interfacing based Experiments (any five)

6. Stepper motor controller interfacing
7. DC Motor interfacing
8. Seven Segment Display interfacing
9. Digital to Analog Convertor interfacing
10. Analog to Digital Convertor interfacing
11. Elevator Simulator interfacing
12. Traffic light controller interfacing
13. Temperature controller interfacing
14. IC Tester interfacing

****Additional or any other experiment may be added based on contents of syllabi.

PEE – 244: MEASUREMENT & INSTRUMENTATION LAB

L T P
0 0 2

1. Calibration of energy meter, voltmeter and ammeter.
2. Determination of frequency and phase angle using CRO.
3. Measurement of low resistance by Kelvin's double Bridge.
4. Measurement of voltage using dc potentiometer.
5. Measurement of inductance by Maxwell's Bridge.
6. Measurement of inductance by Hay's Bridge.
7. Measurement of inductance by Anderson's Bridge.
8. Measurement of capacitance by Owen's Bridge.
9. Measurement of capacitance by De Sauty Bridge.
10. Measurement of capacitance by Schering Bridge.
11. Measurement of frequency using Wein's Bridge.
12. Study the Current and Potential transformers and find out ratio & phase angle error.

****Additional or any other experiment may be added based on contents of syllabi.

TEE- 351: POWER SYSTEM-I (APPARATUS & MODELLING)

L T P
3 1 0

Module 1: Basic Concepts (4 hours)
Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources.Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.

Module 2: Power System Components (15 hours)
Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables.Capacitance and Inductance calculations for simple configurations.Travelling-wave Equations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power.Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines. Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, auto-transformers, Neutral Grounding transformers. Tap-Changing in transformers.Transformer Parameters.Single phase equivalent of three-phase transformers. Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.

Module 3: Over-voltages and Insulation Requirements (4 hours)
Generation of Over-voltages: Lightning and Switching Surges. Protection against Over-voltages, Insulation Coordination.Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams.

Module 4: Fault Analysis and Protection Systems (10 hours)
Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults.Representation of generators, lines and transformers in sequence networks.Computation of Fault Currents.Neutral Grounding. Switchgear: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Module 5: Introduction to DC Transmission & Renewable Energy Systems (9 hours)
DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC). LCC and VSC based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. Solar PV systems: I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Permanent Magnetic Synchronous Generators and Induction Generators. Power Electronics interfaces of wind generators to the grid.

Text/References:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of power systems.

Understand the various power system components.

Evaluate fault currents for different types of faults.

Understand the generation of over-voltages and insulation coordination.

Understand basicprotection schemes.

Understand concepts of HVdc power transmission and renewable energy generation.

TEE-352: CONTROL SYSTEM

L T P
3 1 0

Module 1: Introduction to control problem (4 hours)
Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Module 2: Time Response Analysis (10 hours)
Standard test signals. Time response of first and second order systems for standard test inputs.Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability.Routh-Hurwitz Criteria.Relative Stability analysis.Root-Locus technique.Construction of Root-loci.

Module 3: Frequency-response analysis (6 hours)
Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module 4: Introduction to Controller Design (10 hours)
Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems.Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design.Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs.Analog and Digital implementation of controllers.

Module 5: State variable Analysis and Introduction to Optimal Control and Nonlinear Control (6 hours)
Concepts of state variables.State space model.Diagonalization of State Matrix.Solution of state equations.Eigenvalues and Stability Analysis.Concept of controllability and observability.Pole-placement by state feedback.Discrete-time systems.Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.
Performance Indices.Regulator problem, Tracking Problem.Nonlinear system–Basic concepts and analysis.

Text/References:

1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
3. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
4. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.

Understand the concept of stability and its assessment for linear-time invariant systems.

Design simple feedback controllers.

TEE- 353: POWER ELECTRONICS

L T P
3 1 0

Module 1: Power switching devices (8 Hours)
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (7 Hours)
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC buck converter and DC-DC boost converter (10 Hours)
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.
Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module 4: Single-phase voltage source inverter (10 Hours)
Power circuit of single- phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Module 5: Three-phase voltage source inverter (8 Hours)
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
4. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Course Outcomes:

At the end of this course students will demonstrate the ability to

Understand the differences between signal level and power level devices.

Analyse controlled rectifier circuits.

Analyse the operation of DC-DC choppers.

Analyse the operation of voltage source inverters.

EEE 311: ELECTRICAL MACHINE DESIGN

L T P
3 1 0

Module 1: Introduction
Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Module 2: Transformers
Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Module 3: Induction Motors
Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Module 4: Synchronous Machines
Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Module 5: **Computer aided Design (CAD)**
Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to **c**omplex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
6. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the constructionand performance characteristics of electrical machines.

Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines

Understand the principles of electrical machine design and carry out a basic design of an ac machine.

EEE 312: ELECTRICAL ENERGY CONSERVATION AND AUDITING

L T P
3 1 0

Module 1: Energy Scenario and Basics of Energy and its various forms (12 Hours)
Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.
Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Module 2: Energy Management & Audit (6 Hours)
Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Module 3: Energy Efficiency in Electrical Systems (7 Hours)
Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module 4: Energy Efficiency in Industrial Systems (8 Hours)
Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module 5: Energy Efficient Technologies in Electrical Systems (8Hours)
Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the current energy scenario and importance of energy conservation.

Understand the concepts of energy management.

Understand the methods of improving energy efficiency in different electrical systems.

Understand the concepts of different energy efficient devices.

EEE 313: HIGH VOLTAGE ENGG

L T P
3 1 0

Module 1: Breakdown in Gases, liquid and solid Insulating materials (14 Hours)
Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge
Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Module 2: Generation of High Voltages (7 Hours)
Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Module 3: Measurements of High Voltages and Currents (7 Hours)
Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Module 4: Lightning and Switching Over-voltages (7 Hours)
Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Module 5: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories (7 Hours)
Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.

Text/Reference Books

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

Course outcomes:

At the end of the course, the student will demonstrate

Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.

Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.

Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.

EEE 314: ELECTROMAGNETIC WAVES

L T P
3 1 0

Module 1: Transmission Lines (6 hours)
Introduction, Concept of distributed elements, Equations of voltage andcurrent, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations (6 hours)
Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

Module 3: Uniform Plane Wave (7 hours)
Homogeneous unbound medium, Wave equation for time harmonic fields,Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

Module 4: Plane Waves at Media Interface (7 hours)
Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 5: Waveguidesand Antennas (12 hours)
Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.
Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Text/Reference Books

1. R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics", Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons, 2005.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.

Provide solution to real life plane wave problems for various boundary conditions.

Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.

THS-352: PRINCIPLE OF MANAGEMENT

L T P
3 0 0

PEE 351: POWER SYSTEM-I LAB

L T P
0 0 2

1. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation
2. To study ferranti effect and voltage distribution in long transmission line using transmission line model.
3. Plotting the equipotential lines of single and multilayer cables.
4. To study the performance characteristics of a radial distribution system.
5. To study the performance characteristics of a ring main distribution system.
6. To study and obtain ABCD parameters, h and image parameter of transmission line.
7. To study and obtain the string efficiency of insulators with and without guard ring.
8. To determine direct axis reactance (X_d) and quadrature axis reactance (X_q) of a salient pole alternator.
9. To determine negative and zero sequence reactances of an alternator.
10. To determine sub transient direct axis reactance (xd) and sub transient quadrature axis reactance (xq) of an alternator.

Simulation Based Experiments (using MATLAB or any other software)

11. To determine transmission line parameters of short, medium and long transmission line.
12. To obtain steady state, transient and sub-transient short circuit currents in an alternator.
13. To obtain formation of Y-bus and perform load flow analysis using N-R method.
14. To perform symmetrical fault analysis in a power system.
15. To perform unsymmetrical fault analysis in a power system.

****Additional or any other experiment may be added based on contents of syllabi.

PEE 352: CONTROL SYSTEM LAB

L T P
0 0 2

Hands-on/Computer experiments related to the course contents of Control System.

PEE – 353: POWER ELECTRONICS LAB

L T P
0 0 2

1. To obtain V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase fully controlled by using cosine control scheme.
5. To study three-phase fully and half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cycloconverter.
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor.
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.
11. To study MOSFET/IGBT based single-phase bridge inverter.

Software based experiments (PSPICE/MATLAB)

12. To obtain simulation of SCR and GTO thyristor.
13. To obtain simulation of Power Transistor and IGBT.
14. To obtain simulation of single phase fully controlled bridge rectifier and draw load voltage and load current waveform for inductive load.
15. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.
16. To obtain simulation of step down dc chopper with L-C output filter for inductive load and determine steady-state values of output voltage ripples in output voltage and load current.

****Additional or any other experiment may be added based on contents of syllabi.

TEE 361: POWER SYSTEM-II (OPERATION & CONTROL)

L T P
3 1 0

Module 1: Power Flow Analysis (7 hours)
Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications.Application of numerical methods for solution of non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations.Computational Issues in Large-scale Power Systems.

Module 2: Stability Constraints in synchronous grids (8 hours)
Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve.Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault.Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion.Impact of stability constraints on Power System Operation.Effect of generation rescheduling and series compensation of transmission lines on stability.

Module 3: Control of Frequency and Voltage (7 hours)
Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing.Automatic Generation Control.Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers.

Power flow control using embedded dc links, phase shifters and

Module 4: Monitoring and Control (6 hours)
Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems.State- estimation.System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis.Preventive Control and Emergency Control.

Module 5: **Power System Economics and Management (7 hours)**
Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services.Regulatory framework.

Text/References:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Use numerical methods to analyse a power system in steady state.

Understand stability constraints in a synchronous grid.

EEE 321: LINE COMMUTATED AND ACTIVE PWM RECTIFIERS

L T P
3 1 0

Module 1: Diode rectifiers with passive filtering (6 Hours)
Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape, effect of source inductance; commutation overlap.

Module 2: Thyristor rectifiers with passive filtering (6 Hours)
Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module 3: Multi-Pulse converter and Single-phase ac-dc single-switch boost converter (12 Hours)
Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.
Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module 4: Ac-dc bidirectional boost converter (6 Hours)
Review of 1-phase inverter and 3-phase inverter, power circuits of 1 -phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Module 5: Isolated single-phase ac-dc flyback converter (10 Hours)
Dc-dc flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure.

Text/ References:

1. G. De, “Principles of Thyristorised Converters”, Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, “Principles of Power Electronics”, Addison-Wesley, 1991.
3. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
4. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Analyse controlled rectifier circuits.

Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.

Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode.1

EEE 322: ELECTRICAL DRIVES

L T P
3 1 0

Module 1: DC motor characteristics and Chopper fed DC drive (10 hours)
Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.
Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.

Module 2: Multi-quadrant DC drive (6 hours)
Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four- quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.

Module 3: Closed-loop control of DC Drive (6 hours)
Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.

Module 4: Induction motor characteristics and Scalar control or constant V/f control of induction motor (12 hours)
Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.
Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

Module 5: Control of slip ring induction motor (6 hours)
Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.

Text / References:

1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, 1989.
2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
3. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the characteristics of dc motors and induction motors.

Understand the principles of speed-control of dc motors and induction motors.

EEE 323: INDUSTRIAL ELECTRICAL SYSTEMS

L T P
3 1 0

Module 1: Electrical System Components (8 Hours)
LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Module 2: Residential and Commercial Electrical Systems (8 Hours)
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: Illumination Systems (6 Hours)
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module 4: Industrial Electrical Systems (14Hours)
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Module 5: Industrial Electrical System Automation (6 Hours)
Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books

1. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Course Outcomes:
At the end of this course, students will demonstrate the ability to
Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.Understand various components of industrial electrical systems.

EEE 324: DIGITALCONTROL SYSTEM

L T P
3 1 0

Module 1: Discrete Representation of Continuous Systems (6 hours)
Basics of Digital Control Systems.Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization.Choice of sampling frequency.ZOH equivalent.

Module 2: Discrete System Analysis and Stability of Discrete Time System (10 hours)
Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane.Solution of Discrete time systems.Time response of discrete time system.
Stability analysis by Jury test.Stability analysis using bilinear transformation.Design of digital control system with dead beat response. Practical issues with dead beat response design.

Module 3: State Space Approach for discrete time systems (10 hours)
State space models of discrete systems, State space analysis. Lyapunov Stability.Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module 4: Design of Digital Control System(8 hours)
Design of Discrete PID Controller, Design of discrete state feedback controller.Design of set point tracker.Design of Discrete Observer for LTI System.Design of Discrete compensator.

Module 5: Discrete output feedback control (8 hours)
Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Obtain discrete representation of LTI systems.

Analyse stability of open loop and closed loop discrete-time systems.

Design and analyse digital controllers.

Design state feedback and output feedback controllers.

EEE 331: DIGITAL SIGNAL PROCESSING

L T P
3 1 0

Module 1: Discrete-time signals and systems (6 hours)
Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Samplingand reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Module 2: Z-transform (6 hours)
z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Module 2: Discrete Fourier Transform (10 hours)
Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals

Module 3: Fast Fourier Transform (5 hours)
Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Module 4: Design of Digital filters (12 hours)
Designof FIR Digital filters: Windowmethod,Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations;Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design.Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Module 5: Applications of Digital Signal Processing (6 hours)
Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms And Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Represent signals mathematically in continuous and discrete-time, and in the frequency domain. Analyse discrete-time systems using z-transform.

Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms. Design digital filters for various applications.

Apply digital signal processing for the analysis of real-life signals.

EEE 332: COMPUTER ARCHITECTURE

L T P
3 1 0

Module 1: Introduction to computer organization (6 hours)
Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

Module 2: Memory organization (6 hours)
System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

Module 3: Input – output Organization (8 hours)
Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

Module 4: 16 and 32 microprocessors (8 hours)
80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86

Module 5: Pipelining (8 hours)
Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

Module 6: Different Architectures (8 hours)
VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Reference Books

1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
4. W. Stallings, "Computer organization", PHI, 1987.
5. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.
6. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, "Microcomputer Systems: The 8086/8088 Family", Prentice Hall India, 1986.
8. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
9. B. Govindarajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
10. P. Able, "8086 Assembly Language Programming", Prentice Hall India.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the concepts of microprocessors, their principles and practices.

Write efficient programs in assembly language of the 8086 family of microprocessors. Organize a modern computer system and be able to relate it to real examples.

Develop the programs in assembly language for 80286, 80386 and MIPS processors inreal and protected modes.

EEE 333: COMPUTATIONAL ELECTROMAGNETICS

L T P
3 1 0

Module 1: Introduction (6 hours)
Conventional design methodology, Computer aided design aspects – Advantages. Review of basic fundamentals of Electrostatics and Electromagnetics. Development of Helmhotz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transients and time-harmonic.

Module 2: Analytical Methods (6 hours)
Analytical methods of solving field equations, method of separation of variables, Roth's method, integral methods- Green's function, method of images.

Module 3: Finite Difference Method (FDM) (7 hours)
Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.

Module 4: Finite Element Method (FEM) (7 hours)
Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

Module 5: Special Topics and Applications (14 hours)
{Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (graphical method)}, hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations, method of moments, Poisson's fields.
Low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators.CAD packages.

Text/Reference Books

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press, 1996.
2. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press, 2001.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the basic concepts of electromagnetics.

Understand computational techniques for computing fields. Apply the techniques to simple real-life problems.

EEE 334: CONTROL SYSTEMS DESIGN

L T P
3 1 0

Module 1: Design Specifications (6 hours)
Introduction to design problem and philosophy.Introduction to time domain and frequency domain design specification and its physical relevance.Effect of gain on transient and steady state response.Effect of addition of pole on system performance.Effect of addition of zero on system response.

Module 2: Design of Classical Control System in the time domain (8 hours)
Introduction to compensator.Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation.Realization of compensators.

Module 3: Design of Classical Control System in frequency domain and Design of PID controllers (14 hours)
Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.
Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Module 4: Control System Design in state space (8 hours)
Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Module 5: Nonlinearities and its effect on system performance (3 hours)
Various types of non-linearities.Effect of various non-linearities on system performance.Singular points. Phase plot analysis.

Text and Reference Books:

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R.T. Stefani and G.H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

Course Outcomes: At the end of this course, students will demonstrate the ability to

Understand various design specifications.

Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).

Design controllers using the state-space approach.

THS-362: ENGINEERING ECONOMICS

L T P
3 0 0

TMC-361: ESSENCE OF INDIAN TRADITION KNOWLEDGE

L T P
2 0 0

PEE 361: POWER SYSTEM-II LAB

L T P
0 0 2

1. To study the instantaneous over current relay determine the time-current characteristics.
2. To study the IDMT over current relay and determine the time-current characteristics.
3. To study the earth fault relay and determine the time-current characteristics.
4. To study the thermal relay and determine the time-current characteristics.
5. To study percentage differential relay and plot its operating characteristics.
6. To study Impedance, MHO and Reactance type distance relays.
7. To study over-voltage relay and determine the time-voltage characteristics.
8. To study under-voltage relay and determine the time-voltage characteristics.
9. Measurement of earth resistance using Megger.

PEE 362: ELECTRONICS DESIGN LAB

L T P
0 0 2

Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Text/Reference Books

1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

Course Outcomes:

At the end of the course, studentswilldemonstrate the ability to

Understandthe practical issues related to practicalimplementation of applications usingelectronic circuits.

Chooseappropriate components, software and hardware platforms.

Design a Printed Circuit Board, getit made and populate/solder itwith components. Work as a team withotherstudents to implement an application.

EEE 441: WIND AND SOLAR ENERGY SYSTEMS

L T P
3 1 0

Module 1: Physics of Wind Power: (5 Hours)
History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Module 2: Wind generator topologies: (12 Hours)
Review of modern wind turbine technologies,Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Module 3: The Solar Resource and Solar photovoltaic (11 Hours)
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.
Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms.Converter Control.

Module 4: Network Integration Issues: (8 Hours)
Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Module 5: Solar thermal power generation: (3 Hours)
Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text / References:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**"**, John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.

Understand the basic physics of wind and solar power generation.

Understand the power electronic interfaces for wind and solar generation.

Understand the issues related to the grid-integration of solar and wind energy systems.

EEE 442: ELECTRICAL AND HYBRID VEHICLES

L T P
3 1 0

Module 1: Introduction (5 hours)
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module 2: Introduction to Hybrid Electric Vehicles (5 hours)
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module 3: Electric Trains (10 hours)
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module 4: Energy Storage (10 hours)
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Module 5: Energy Management Strategies (9 hours)
Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the models to describe hybrid vehicles and their performance.

Understand the different possible ways of energy storage.

EEE 443: POWER SYSTEM PROTECTION

L T P
3 1 0

Module 1: **Introduction and Components of a Protection System and Faults and Over-Current Protection (12 hours)**

Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination.

Module 2: **Equipment Protection Schemes (8 hours)**

Directional, Distance, Differential protection.Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes.

Module 3: **Digital Protection (8 hours)**

Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.

Module 4:**Modeling and Simulation of Protection Schemes (8 hours)**

CT/PT modeling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.

Module 5: **System Protection (4 hours)**

Effect of Power Swings on Distance Relaying.System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

Text/References

1. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, 2008.
5. D. Reimert, "Protective Relaying for Power Generation Systems", Taylor and Francis, 2006.

Course Outcomes: At the end of this course, students will demonstrate the ability to

Understand the different components of a protection system.

Evaluate fault current due to different types of fault in a network.

Understand the protection schemes for different power system components.

Understand the basic principles of digital protection.

Understand system protection schemes, and the use of wide-area measurements.

EEE-444: INTELLIGENT SYSTEMS

L T P
3 1 0

Unit-1

Neural Networks (Introduction & Architecture): Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory

Unit-2

Neural Networks (Contd.)(Back propagation networks): Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient; backpropogation algorithm, factors affecting back propagation training, applications.

Unit-3

Fuzzy Logic (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory versus probability theory, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

Unit-4

Fuzzy Logic (Contd.) (Fuzzy Membership, Rules): Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzifications, Fuzzy Controller.

Unit-5

Genetic Algorithm: Introduction, mutation, population, cross over.

Application ofGenetic Algorithm, Neural Network and Fuzzy logic, case study, Inverted pendulum, Image processing. Introduction to Neuro - Fuzzy logic controller.

Books:

1. Kumar Satish, “Neural Networks” Tata McGraw Hill
2. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications” Prentice Hall of India.
3. Simon Haykin, “Neural Networks” Prentice Hall of India
4. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.

EEE 451: HVDC TRANSMISSION SYSTEMS

L T P
3 1 0

Module 1: DC Transmission Technology (4 hours)
Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability).Application of DC Transmission.Types of HVdc Systems.Components of aHVdc system. Line Commutated Converter and Voltage Source Converter based systems.

Module 2: Analysis of Line Commutated and Voltage Source Converters (10 hours)
Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters.Inverter Operation.Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters.Effect of Commutation Failure, Misfire and Current Extinction in LCC links.Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.

Module 3: Control of HVdc Converters: (10 hours)
Principles of Link Control in aLCCHVdc system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers.Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.

Module 3: Components of HVdc systems: (8 hours)
Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects.Insulators, Transient Over-voltages.dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation.Ground Electrodes.

Module 4: Stability Enhancement using HVdc Control (4 hours)
Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.

Module 5: MTdc Links (4 hours)
Multi-Terminal and Multi-Infeed Systems.Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology.Introduction to Modular Multi-level Converters.

Text/References:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the advantages of dc transmission over ac transmission.

Understand the operation of Line Commutated Converters and Voltage Source Converters.

Understand the control strategies used in HVdc transmission system.

Understand the improvement of power system stability using an HVdc system.

EEE 452: POWER QUALITY AND FACTS

L T P
3 1 0

Module 1: Transmission Lines and Series/Shunt Reactive Power Compensation and Thyristor-based Flexible AC Transmission Controllers (FACTS) (10 hours)

Basics of AC Transmission.Analysis of uncompensated AC transmission lines.Passive Reactive Power Compensation.Shunt and series compensation at the mid-point of an AC line.Comparison of Series and Shunt Compensation.

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.

Module 2: Voltage Source Converter based (FACTS) controllers (8 hours)

Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.

Module 3: Application of FACTS and Power Quality Problems in Distribution Systems (8 hours)

Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.

Module 4: DSTATCOM (8 hours)

Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters.Synchronous Reference Frame Extraction of Reference Currents.Current Control Techniques in for DSTATCOM.

Module 5: Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours)

Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering.Unified Power Quality Conditioner (UPQC): Working Principle.Capabilities and Control Strategies.

Text/References

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.
5. G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.

Understand the working principles of FACTS devices and their operating characteristics.

Understand the basic concepts of power quality.

Understand the working principles of devices to improve power quality.

EEE 453: POWER SYSTEM DYNAMICS AND CONTROL

L T P
3 1 0

Module 1: Introduction to Power System Operations (3 hours)
Introduction to power system stability.Power System Operations and Control.Stability problems in Power System.Impact on Power System Operations and control.

Module 2: Analysis of Linear Dynamical System and Numerical Methods (5 hours)
Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability.Modal Analysis of Linear System.Analysisusing Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

Module 3: Modeling of Synchronous Machines and Associated Controllers (12 hours)
Modeling of synchronous machine: Physical Characteristics.Rotor position dependent model.D-Q Transformation.Model with Standard Parameters.Steady State Analysis of Synchronous Machine.Short Circuit Transient Analysis of a Synchronous Machine.Synchronization of Synchronous Machine to an Infinite Bus.Modeling of Excitation and Prime Mover Systems.Physical Characteristics and Models.Excitation System Control.Automatic Voltage Regulator.Prime Mover Control Systems. Speed Governors.

Module 4: Modeling of other Power System Components (10 hours)
Modeling of Transmission Lines and Loads.Transmission Line Physical Characteristics.Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

Module 5: Stability Analysis and Enhancing System Stability (15 hours)
Angular stability analysis in Single Machine Infinite Bus System.Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governordroop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools:Transient Stability Programs, Small Signal Analysis Programs.
Planning Measures.Stabilizing Controllers (Power System Stabilizers).Operational Measures-Preventive Control.Emergency Control.

Text/Reference Books

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2002.
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall, 1997.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the problem of power system stability and its impact on the system.

Analyse linear dynamical systems and use of numerical integration methods.

Model different power system components for the study of stability.

Understand the methods to improve stability.

EEE-454: MACHINE MODELLING

LT P
3 1 0

Unit-1:
Transformations: Electromechanical Energy-Conversion Principles, Kron's Primitive machine, General expression of voltage, force and torque, Basic modeling of electrical machines from coupled circuit point of view. Techniques of transformations, reference frames, operationalized equivalent circuit.

Unit-2:
Modeling of D. C. Machines: Analysis of motoring and generating action under steady state, transient and dynamic simulation, Effect of load change under dynamic conditions for different excitations, reversal and braking.

Unit-3:
Modeling of Synchronous Machines: dq transformation**,** Concepts of Time varying inductancessteady state and dynamic equations, Phasor diagram of Synchronous Machines, Electromagnetic and reluctance torque, Synchronous Machines dynamics,Response under short circuit, sub transient and transient condition. Dynamic simulation of vector controlled synchronous machines.

Unit-4:
Modeling of Poly-phase Induction Machines: Equations under stationary, rotating and synchronous reference frames**,** derivation of torque and power expression, Equivalent circuit, Concepts of Time varying inductances, Dynamic under load changes, run up time, Speed reversal and braking.Computer simulation for dynamic response.

Unit-5:
Doubly fed induction motor: Principles, operation its control. Induction generator: principles and operations. Doubly fed induction generator: principles and operations.

Books:
1. A. E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, "Electrical Machinery", McGraw-Hill .
2. P. S. Bhimra, "Generalized Theory of Machines", Khanna Publications.
3. R. Krishnan "" Modeling, Analysis and Control of Electric Drives.

THS-472: PROJECT MANAGEMENT & ENTREPRENEURSHIP

L T P
3 0 0

EEE 461: ADVANCED ELECTRIC DRIVES

L T P
3 1 0

Module 1: Power Converters for AC drives (10 hours)
PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

Module 2: Induction motor drives (10 hours)
Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control(DTC).

Module 3: Synchronous motor drives (6 hours)
Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Module 4: Permanent magnet motor drives (6 hours)
Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Module 5: Switched reluctance motor drives and DSP based motion control (12 hours)
Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.
Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

Text / References:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P.C. Krause, O. Wasynczuk and S.D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Understand the operation of power electronic converters and their control strategies.

Understand the vector control strategies for ac motor drives

Understand the implementation of the control strategies using digital signal processors.

EEE-462: ADVANCED POWER ELECTRONICS

L T P
3 1 0

Unit-1

Power Supplies: Desirable specification of power supply, drawback of linear power supply. Switch mode power supply (SMPS)-schematic diagram, fly back converters, forward converter, push pull converters, half bridge and full bridge converter; uninterruptible power supply (UPS)-configuration of line and online UPS, switch mode and resonant power supplies, air craft power supply.

Unit-2

Industrial Applications: High frequency inverters for induction and dielectric heating, ac voltage controllers for resistance heating and illumination control, high frequency fluorescent lighting, electric welding control.

Unit-3

Effect of Harmonics: Parallel and series resonance, Effect of harmonics on static power plant transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement.

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Unit-4

Elimination/Suppression of Harmonics: High power factor converter, multi-pulse converters using transformer connections (Delta, polygon)

Passive Filters: Types of passive filters, single tuned and high pass filters, filer design criteria, double tuned filters, damped filters and their design.

Unit-5

Active Power filters: Compensation principle, classification of active filters by objective, systems configuration, power circuit and control strategy.

Shunt Active Filter: Single phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three phase active filter: Operation, analysis and modeling; Instantaneous reactive power theory.

Other Techniques: Unified Power Quality Conditioner, voltage source and current configurations, principle of operation for sag, swell and flicker control.

Books:

1. Ned Mohan, T. M. Undeland and William P. Robins, "Power Electronics: Converters, Applications and Design", John Wiley & Sons.

2. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications" Prentice Hall of India.

3. K.R. Padiyar, "HVDC Power Transmission: Technology and System Reactions" New Age International.

4. Roger C. Dugan, Mark F. McGranhgan, Surya Santoso, "Electrical Power System Quality" McGraw hill, 2nd Edition.

5. Arindam Ghosh and Gerard Ledwich, "Power Quality Enhancement using custom power devices ", Kulwer academic publishers.

EEE-463: POWER SYSTEM TRANSIENTS

L T P
3 1 0

Unit-1

Transients: Concept of transients, genesis and classification, Circuit Closing Transient, Recovery Transient, Double Frequency Transients. Resistance and Load Switching, Normal and Abnormal Switching Transients, Current Suppression, Capacitance Switching, Re-striking Phenomena, Transformer Magnetizing Inrush Current, Ferro-resonance. Introduction of lightning phenomena and protection against lightning.

Unit-2

Transients in 3-φ Circuits: Introduction, Importance of Neutral Connection, 3-φ Reactor with Isolated Neutral, 3-φ Capacitance Switching, Symmetrical Component Method for Solving 3-φ Switching Transients,Y-Δ Transformer, Circuit Reduction.

Unit-3

Travelling Waves and Other Transients on Transmission Lines: Circuits with Distributed Constants, Wave Equation, Reflection and Refraction of Travelling Waves, Travelling Waves at Line Terminations, Lattice Diagram, Attenuation and Distortion of Travelling Waves, Multi-conductor Systems and Multi-velocity Waves.

Unit-4

Transients in the Integrated Power System: Introduction, Short Line or Kilometric Fault, Line Dropping and Load Rejection, Voltage Transients on Closing and Reclosing Lines, Switching HVDC Lines, Switching Surges on an Integrated System.

Unit-5

Protection of Systems and Equipment against Transient Over-voltages: Protection of Transmission Lines against Lightning, Surge Suppressors and Lightning Arresters, Application of Surge Arresters, Surge Capacitors and Reactors, Surge Protection of Rotating Machines. Transient Voltages and Grounding Practices.

Books:

1. Joseph B. Aidala and Leon Katz, “Transients in Electric Circuits”, Prentice Hall.
2. Allan Greenwood, “Power System Transients”.

EEE-464: BIOMEDICAL INSTRUMENTATION

LT P
3 1 0

Unit -1

Introduction to Biomedical Instrumentation: Components of the man- instrument system, Specifications of medical instrumentation systems, Problem encountered in measuring living system, Basic transducers principles, Active and passive transducers, transducer for biomedical applications.

Unit -2

Bioelectric Potentials:Introduction to bioelectric potentials,Generation, propagation and distribution of bioelectric potential (ECG, EEG and EMG), Biopotential electrodes, Microelectrodes, skin surface electrodes and needle electrodes, Biochemical transducers (pH electrode, blood gas electrodes and specific ion electrodes).

Unit -3

Electrocardiogram (ECG): Anatomy of heart, Block diagram of electrocardiograph, ECG amplifier, ECG lead configuration, ECG recording, Electroencephalogram (EEG): Anatomy of nervous system, Block diagram of Electrocardiograph, Electromyogram (EMG): Block diagram of EMG instrument, Electrodes for EMG.

Unit -4

Blood pressure measurement, Blood flow measurement, Systematic skin and body temperature measurement, Elements of intensive care unit, Pacemakers, Defibrillators, Biotelemetry and application of telemeter in patient care.

Unit -5

Imaging techniques:Production of x-rays, block diagram of x-ray machine, x-rays Imaging techniques - CAT scan. Ultrasound imaging system, Principle & image reconstruction techniques of NMR and MRI; Application of computer in medical instrumentation; Shock hazards from electrical equipment, methods of accident prevention.

Books:

1. Cromwell– Biomedical Instrumentation and Measurements- PHI
2. Webster, J.G. – Bio- Instrumentation, Wiley (2004)
3. Khandpur R. S – Handbook of Biomedical Instrumentation", Tata McGraw Hill.

SYALLBUS OF OPEN ELECTIVE SUBJECTS:

TOE 50: ELECTRICAL MACHINE

L T P
3 0 0

Unit-I

Principles of Electro-mechanical Energy Conversion: Introduction, Flow of Energy in Electromechanical Devices, Energy in magnetic systems-Field energy & Co-energy, Singly-Excited Systems and Doubly-excited Systems-generalized expression of torque, reluctance and electromagnetic torques.

Unit-II

D. C. Machines: Constructing feature and principal of operation of shunt, series and compound generators and motors including emf equation and armature reaction. Performance characteristics of generators and motors, starting, speed control and breaking of motors. Two quadrant and four quadrant operation of motors, choice of DC motors for different applications, losses and efficiency.

Unit-III

Transformers: Construction, EMF equation, Principle of operation, phasor diagram on no-load, effect of load, equivalent circuit, voltage regulation, Losses and efficiency, Tests on transformers, Prediction of efficiency and regulation, Auto transformers, Instrument transformers, Three phase transformers.

Unit-IV

Induction Motors: Rotating magnetic fields, Principle of operation, Equivalent circuit, Torque-slip characteristic,Starters for cage and wound rotor type induction motors, speed control and breaking, single phase induction motors and methods of starting.

Unit-V

Synchronous Machines: Construction, EMF, Effect of pitch and distribution, Armature reaction and determination of regulation of synchronous generators, Principle of motor operation, Effect of excitation on line current (V-curves). Methods of synchronization, Typical applications of AC motors in industries.

References:

1. I. J. Nagrath & D.P.Kothari, " Electrical Machines", Tata McGraw Hill.
2. Bhimbra P. S., "Electrical Machinery" Khanna Publication
3. A. E. Fitggerald, C. Kingsley Jr and Umans," Electric Machinery" 6th Edition McGraw Hill, International Student Edition.
4. Irving L. Kosow, "Electric Machine and Tranformers", Prentice Hall of India.
5. M. G. Say, "The Performance and Design of AC machines", Pit man & Sons.
6. Bhag S. Guru and Huseyin R. Hizirogulu, "Electric Machinery and Transformers" Oxford University Press, 2001.
7. Ashfaq Hussain, "Electric Machines" Dhanpat Rai & Company

TOE 51: NON-CONVENTIONAL ENERGY SYSTEM

L T P
3 0 0

Unit-1

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits.

Solar Cells: Theory of solar cells, Solar cell materials, solar cell array, solar cell power plant, limitations.

Unit-2

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

Unit-3

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.

Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations.

Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

Unit-4

Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.

Unit-5

Bio-mass: Availability of bio-mass and its conversion theory.

Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations.

Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

Text/References Books:

1. Raja etal, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
3. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional" BSP Publications,2006.
4. D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.

TOE 52: DIGITAL CONTROL SYSTEM

L T P
3 0 0

Module 1: Discrete Representation of Continuous Systems (6 hours)
Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Module 2: Discrete System Analysis and Stability of Discrete Time System (10 hours)
Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.
Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

Module 3: State Space Approach for discrete time systems (10 hours)
State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Module 4: Design of Digital Control System(8 hours)
Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Module 5: Discrete output feedback control (8 hours)
Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

Course Outcomes:

At the end of this course, students will demonstrate the ability to

Obtain discrete representation of LTI systems.

Analyse stability of open loop and closed loop discrete-time systems.

Design and analyse digital controllers.

Design state feedback and output feedback controllers.

TOE 53: POWER STATION PRACTICE

L T P
3 0 0

Unit-1
Economicaspects of generation
Basic concept on generation, transmission and distribution, type of loads: industrial, commercial, and agricultural, Load curve, load duration curve, load factor, capacity factor, diversity factor. Base load station and peak load station, captive power plants, operating & spinning reserves. Load forecasting and its solving techniques, site selection of thermal, hydroelectric, nuclear, diesel and gas power plants.

Unit-2:
Tariffs and Power factor
Electric utility services, general tariff forms and different types of tariffs, concept of power and energy in electrical system, maximum demand indicators and recorders. Evolution and definition of power factor (pf), concept of pf lagging & leading, zero pf lagging & leading, causes and effects of low power factor, necessity of power factor improvement and power factor improvement techniques.

Unit-3:
Power Plants and their coordinated operation
Type of power plants and their operation: thermal, hydroelectric, nuclear with nuclear fuel processing and waste handling, diesel and gas. Field of application of power plants, advantages of coordinated operation of different types of power plants, hydro–thermal scheduling, short-term and long-term hydrothermal scheduling (without derivation), steam power plant coordination with run-off river, dam storage, pumped storage and gas turbine plants.

Unit-4:
Non-conventional energy sources (NCES) and Magneto-hydro-dynamic (MHD) generators
Type of NCES and their operation: solar, wind, tidal, geo-thermal, MHD generator. Open and closed cycle operation of MHD generators with advantages, problems, and future trends.

Unit-5:
Power station auxiliaries
Types of Turbines and their operation: Pelton, Francis, and Kaplan. Fuel feeding system both for coal and biomass fuel, boilers, governors, excitation system, auto voltage regulators (AVR), busbar arrangements, battery charger.

Books:
1. B. R. Gupta, ‘Generation of electric energy’ (Eurasia publishing house; Delhi).
2. M. V. Deshpande, ‘Elements of power station design’ (wheeler Publishing houses).
3. Soni, Gupta, Bhatnagar and Chakrabarti, A Textbook on ‘Power System (A Course in Electrical Power)’.

TOE 54: MODERN CONTROL SYSTEM

L T P
3 0 0

Unit-1

Introduction to control systems: Introduction to control systems, properties of signals and systems. Convolution integral, Ordinary differential equation, Transfer function, Pole zero concepts, effect of pole location on performance specification.

Unit-2

State Space analysis: State equations for dynamic systems, State equations using phase, physical and canonical variables, realization of transfer matrices, Solution of state equation, concepts of controllability, observability, Controllability and Observability tests.

Unit-3

Discrete time control systems: Sampling theorem, Sampled-data systems, the sample and hold element, pulse transfer function, The Z transform, stability analysis.

Unit-4

Stability: Liapunov's method, generation of Liapunov's function, Popov's criteria, design of state observers and controllers, adaptive control systems, model reference.

Unit-5

Optimal Control: Introduction , formation of optimal control problems, calculus of variation, minimization of functions, constrained optimization, dynamic programming, performance index , optimality principles, Hamilton – Jacobian equation, linear quadratic problem, Ricatti II equation and its solution, solution of two point boundary value problem

Books:

1. K. Ogata, "Modern Control Engineering", Prentice Hall of India.
2. M. Gopal, "Modern Control System", Wiley Eastern.
3. B. D. O. Anderson and IB. Moore, " Optimal Control System: Linear Quadratic Methods", PHI.
4. U. Itkis, "Control System of Variable Structure", John Wiley and Sons.
5. H. Kwakemaok and R. Sivan, "Linear Optimal Control System", Wiley Interscience.

TOE 55: ELECTRICAL MATERIAL

L T P
3 0 0

UNIT – 1
Crystal Structure of Materials
Bonds in solids, crystal structure, co-ordination number, atomic radius representation of plane distance b/w two planed packing factor, Miller Indices, Bragg's law and x-ray diffraction, structural Imperfections, crystal growth.

UNIT – 2
Dielectric Materials
Polarization and Dielectric constant, Dielectric constant of mono-atomic, Poly atomic gases and solids, frequency dependence of electronic and ionic polarizabilities, dipolar relaxation, dielectric loss, piezoelectricity, ferroelectric materials.

UNIT – 3
Conductivity
Electron theory of metals, factors affecting electrical resistance of materials, thermal conductivity of metals, heat developed in current carrying conductors, Half effect, Drift and Diffusion currents, continuity equation, thermoelectric effect.

UNIT – 4
Conducting and Insulating Materials
Properties and applications of electrical conducting and insulating materials, mechanical properties of metals, Properties of semi-conducting materials, Properties of insulating materials, Superconductivity and super conducting materials, optical properties of solids.

UNIT – 5
Magnetic Material
Origin of permanent magnetic dipoles in matters, Classification, Diamagnetism, Para-magnetism, Ferromagnetism, Anti-ferromagnetism and Ferrimagnetism, magnetostriction, Properties of magnetic materials, soft and hard magnetic materials, permanent magnetic materials.

Books:
1. A. J. Dekker, "Electrical Engineering Materials" Prentice Hall of India.
2. Solymar, "Electrical Properties of Materials" Oxford University Press.
3. Ian P. Hones," Material Science for Electrical and Electronic Engineering," Oxford University Press.

TOE 56: INTELLIGENT SYSTEM

L T P
3 0 0

Unit-1

Neural Networks (Introduction & Architecture): Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory

Unit-2

Neural Networks (Contd.)(Back propagation networks): Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient; backpropogation algorithm, factors affecting back propagation training, applications.

Unit-3

Fuzzy Logic (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory versus probability theory, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

Unit-4

Fuzzy Logic (Contd.) (Fuzzy Membership, Rules): Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzifications, Fuzzy Controller.

Unit-5

Genetic Algorithm: Introduction, mutation, population, cross over.
Application ofGenetic Algorithm, Neural Network and Fuzzy logic, case study, Inverted pendulum, Image processing. Introduction to Neuro - Fuzzy logic controller.

Books:

1. Kumar Satish, "Neural Networks" Tata McGraw Hill
2. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" Prentice Hall of India.
3. Simon Haykin, "Neural Networks" Prentice Hall of India
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.

TOE 57: BIO MEDICAL SIGNAL PROCESSING

L T P
3 0 0

Unit -1

Introduction to Biomedical Instrumentation: Components of the man- instrument system, Specifications of medical instrumentation systems, Problem encountered in measuring living system, Basic transducers principles, Active and passive transducers, transducer for biomedical applications.

Unit -2

Bioelectric Potentials:Introduction to bioelectric potentials,Generation, propagation and distribution of bioelectric potential (ECG, EEG and EMG), Biopotential electrodes, Microelectrodes, skin surface electrodes and needle electrodes, Biochemical transducers (pH electrode, blood gas electrodes and specific ion electrodes).

Unit -3

Electrocardiogram (ECG): Anatomy of heart, Block diagram of electrocardiograph, ECG amplifier, ECG lead configuration, ECG recording, Electroencephalogram (EEG): Anatomy of nervous system, Block diagram of Electrocardiograph, Electromyogram (EMG): Block diagram of EMG instrument, Electrodes for EMG.

Unit -4

Blood pressure measurement, Blood flow measurement, Systematic skin and body temperature measurement, Elements of intensive care unit, Pacemakers, Defibrillators, Biotelemetry and application of telemeter in patient care.

Unit -5

Imaging techniques:Production of x-rays, block diagram of x-ray machine, x-rays Imaging techniques - CAT scan. Ultrasound imaging system, Principle & image reconstruction techniques of NMR and MRI; Application of computer in medical instrumentation; Shock hazards from electrical equipment, methods of accident prevention.

Books:

1. Cromwell– Biomedical Instrumentation and Measurements- PHI
2. Webster, J.G. – Bio- Instrumentation, Wiley (2004)
3. Khandpur R. S – Handbook of Biomedical Instrumentation”, Tata McGraw Hill.

TOE 58: ADVANCED INSTRUMENTATION

L T P
3 0 0

Unit-1

Introduction: Basics of transducer, sensor and actuator; Active and passive transducers; Primary and secondary transducers; Analog and digital transducers; inverse transducers; Static characteristics of transducer and transducer system; Dynamic characteristics of nth, 0th, first and second order transducers.

Measurement of Displacement and Strain: Resistive, inductive and capacitive transducers for displacement; Wire, metal film and semiconductor strain gauges, Wheatstone-bridge circuit with one, two and four active elements, temperature compensation.

Unit -2

Measurement of Force and Pressure: Column, ring and cantilever-beam type load cells; Elastic elements for pressure sensing; Using displacement sensors and strain gauges with elastic elements.

Measurement of Temperature: Resistance temperature detector, NTC and PTC thermistors, Seebeck effect, thermocouple and thermopile.

Measurement of Flow and Liquid Level.

Unit -3

Measurement of Vibrations: Importance of vibration measurement, frequency range of vibrations; Absolute displacement, velocity and acceleration pick-ups; Mass-spring-damper system as absolute acceleration to relative displacement converter; Strain gauge and piezoelectric type acceleration pickups.

Measurement of Speed and Torque: Electro-magnetic and photoelectric tachometers; **Torque:** shaft, strain-gauge, electromagnetic and radio type torque meters.

Unit -4

Telemetry: Meaning and basic scheme of telemetry; DC voltage and current telemetry schemes; Radio telemetry; PWM and digital telemetry schemes.

Data Acquisition System: Analog data acquisition system, digital data acquisition system, Modern digital data acquisition system.

Unit -5

Display Device and Recorders: Display devices, storage oscilloscope, spectrum analyzer, strip chart and x-y recorders, magnetic tape and digital tape recorders.

Recent Developments: Computer aided measurements, fibre optic transducers, micro sensors, smart sensors, and smart transmitters.

Books:

1. A. K. Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai & Sons
2. B.C. Nakra& K. Chaudhary, "Instrumentation, measurement and analysis", Tata McGraw Hill 2nd Edition
4. Dally. "Instrumentation for Engineering Measurement" 2nd edition, Wiley India

TOE 59: INDUSTRIAL PROCESS CONTROL

L T P
3 0 0

Unit I: Transducer – I
Definition, advantages of electrical transducers, classification, characteristics, factor affecting the choice of transducers, Potentiometers, Strain gauges, Resistance thermometer Thermisters, Thermocouples, LVDT, RVDT.

Unit II: Transducer – II
Capacitive, Piezoelectric Hall effect and opto-electronic transducers. Measurement of motion, Force pressure, temperature, flow and liquid level.

Unit III: Telemetry
General telemetry system, land line & radio frequency telemetering system, transmission channel and media, receiver & transmitter. Data Acquisition System:
Analog data acquisition system, modern digital data acquisition system, modern digital data acquisition system.

Unit IV: Display Devices and Recorders
Display devices, storage oscilloscope, spectrum analyzer, strip chart & x-y recorders, magnetic tape & digital tape recorders.

Recent Developments
Computer aided measurements, fibro optic transducers, microprocessors, and smart sensors smart transmitters.

Unit V: Process Control
Principal element of process control system, process characteristics, proportional (P), Integral (I), derivative (D), PI, PD & PID control modes. Electronic, Pneumatic & digital controllers.

Text Book:

1. A.K Sawhney," Advance measurement & instrumentation", Dhanpat Rai & Sons.
2. B.C Nakara & K Chaudhry, instrumentation, measurement & analysis", Tata Mc Graw Hill 2nd Edition.
3. Curtis Johns, "Process Control Instrumentation Technology", Prentice Hall.

Reference book:

1. E.O Decblin, "Measurement system-application & design", mc Graw Hill.
2 . W.D Cooper & A.P Beltried,"Electronics Instrumentation and Measurement Techniques" Prentice Hall International.
3. Rajendera Prasad, "Electronic Measurement & Instrumentation Khanna Publisher.

Structure of Undergraduate Engineering program:

S.No.	Topic	Credits of the EE Curriculum	
		Standard Credits as per AICTE Norms	Actual Credits of the Department of Electrical Engineering
1	Humanities and Social Sciences including Management	12	12
2	Basic Sciences	26	22
3	Engineering Sciences including workshop, drawing, basics of electrical/mechanical/computer etc.	20	20
4	Professional Core Subjects	53	64
5	Professional Subjects: Subjects relevant to chosen specialization/branch	18	24
6	Open Subjects: Electives from other technical and/or emerging Subjects	18	18
7	Project work, seminar and internship in industry or elsewhere	11	15
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	Non- Credit	Non-Credit
	Total	158	175