NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SCHEME OF INSTRUCTION AND SYLLABI
FOR B.TECH PROGRAM

Effective from 2015-16

DEPARTMENT OF ELECTRICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To excel in education, research and technological services in electrical engineering in tune with societal aspirations.

MISSION

- Impart quality education to produce globally competent electrical engineers capable of extending technological services
- Engage in research & development in cutting edge and sustainable technologies.
- Nurture scientific temperament, professional ethics and industrial collaboration

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

DEPARTMENT OF ELECTRICAL ENGINEERING

B.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

PEO1.	Design and develop innovative products and services in the field of electrical and electronics engineering and allied engineering disciplines
PEO2.	Apply the knowledge of electrical and electronics engineering to solve problems of social relevance, pursue higher education and research
PEO3.	Work effectively as individuals and as team members in multidisciplinary projects.
PEO4.	Engage in lifelong learning, career enhancement and adopt to changing professional and societal needs

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4
Impart quality education to produce globally competent electrical engineers capable of extending technological services	3	3	2	2
Engage in research & development in cutting edge and sustainable technologies.	1	2	1	3
Nurture scientific temperament, professional ethics and industrial collaboration.	3	3	2	2

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PEO1	2	1	3	2	2	-	-	-	-	-	-	-
PEO2	1	3	3	3	-	3	-	-	-	-	-	-
PEO3	3	-	-	-	-	-	-	-	3	2	3	-
PEO4	-	-	-	-	-	2	2	1	-	-	-	3

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Specify, design and analyze systems that efficiently generate, transmit and distribute electrical power
PO2	Analyze and design modern electrical drive systems and modern lighting systems
PO3	Understand the principles and construction of electrical machine and determine their performance through testing
PO4	Specify, design, implement and test analog and embedded signal processing electronic systems using the state of the art components and software tools.
PO5	Design controllers for electrical and electronic systems to improve their performance
PO6	Understand how the organizations work, generate wealth, and manage their finances.
PO7	Work in a team using common tools and environments to achieve project objectives and communicate ideas.
PO8	Understand and practice professional ethics in functioning.
PO9	Recognize professional and personal responsibility to the community
PO10	Keep abreast of latest developments in the field.

Mapping of program outcomes with program educational objectives

PO	PEO1	PEO2	PEO3	PEO4
2	3	2	1	-
2	3	2	2	-
3	-	2	-	-
4	3	3	2	-
5	3	2	2	-
6	1	2	2	2
7	1	-	3	-
8	-	1	-	2
9	-	3	3	3
10	-	3	-	3

CURRICULAR COMPONENTS

Degree Requirements for B. Tech in Electrical and Electronics Engineering

Category of Courses Credits Offered		Credits offered	Min. credits to be earned
BSC	Basic Science Core (BSC)	28	28
ESC	Engineering Science Core (ESC)	36	36
HSC	Humanities and Social Science Core(HSC)	7	7
PCC	Program Engineering Core (PCC)	89	89
DEC	Program Engineering Elective (DEC)	24	18
OPC	Open Elective Course (OPC)	6	6
PRC	Program Major Project	6	6
MDC	EAA: Games and Sports (MDC)	0	0
	TOTAL	196	190

SCHEME OF INSTRUCTION

B.Tech. (Electrical and Electronics Engineering) Course Structure

B. Tech. I - Year I - Semester

Sl. No.	Course code.	Course Title	L	T	P	Credits	CAT Code
1	MA 101	Mathematics – I	4	0	0	4	BSC
2	HS 101	English for Communication (or)	3	0	2	4	HSC
	ME 102	Engineering Graphics	2	0	3	4	ESC
3	PH 101	Physics (or)	3	1	0	4	BSC
	CY 101	Chemistry	3	1	0	4	BSC
4	EC 101	Basic Electronics Engineering (or)	3	0	0	3	ESC
	EE 101	Basic Electrical Engineering	3	0	0	3	ESC
5	CE 102	Environmental Science and Engineering	3	0	0	3	ESC
	ME101	Basic Mechanical Engineering	3	0	0	3	ESC
6	CS 101	Problem Solving & Computer Programming(PSCP) (or)	3	1	0	4	ESC
	CE101	Engineering Mechanics	3	1	0	4	ESC
7	PH 102	Physics Laboratory (or)	0	0	3	2	BSC
	CY102	Chemistry laboratory	3	1	0	2	BSC
8	CS 102	PSCP Lab (or)	0	0	3	2	ESC
	ME 103	Workshop practice	0	0	3	2	ESC
9	EA 101	Extra Academic Activity	0	0	3	0	MDC
		Total	**21**	**0**	**11**	**26**	
			20	**0**	**12**	**26**	

B.Tech. I - Year II - Semester

Sl. No.	Course code.	Course Title	L	T	P	Credits	CAT code
1	MA 151	Mathematics – II	3	1	0	4	BSC
2	ME 102	Engineering Graphics/ (or)	2	0	3	4	ESC
	HS101	English for communication	3	0	2	4	HSC
3	CY 101	Chemistry (or)	3	1	0	4	BSC
	PH101	Physics	3	1	0	4	BSC
4	EE 101	Basic Electrical Engineering (or)	3	0	0	3	ESC
	EC101	Basic Electronics Engineering	3	0	0	3	ESC
5	ME 101	Basic Mechanical Engineering (or)	3	0	0	3	ESC
	CE102	Environmental studies	3	0	0	3	ESC
6	CE 101	Engineering Mechanics	3	1	0	4	ESC
	CS101	Problem solving & Computer programming(PSCP)	3	1	0	4	ESC
7	CY 102	Chemistry Laboratory/	0	0	3	2	BSC
	PH102	Physics laboratory	0	0	3	2	BSC
8	ME 103	Workshop Practice/	0	0	3	2	ESC
	CS102	PSCP Lab	0	0	3	2	ESC
9	EA 151	Extra Academic Activity	0	0	3	0	MDC
		Total	**20**	**0**	**12**	**26**	
			21	**0**	**11**	**26**	

II - Year I - Semester

Sl. No.	Course code.	Course Title	L	T	P	Credits	CAT code
1	MA 201	Mathematics – III	3	1	0	4	BSC
2	EC 235	Analog Electronics	3	1	0	4	PCC
3	CS 235	Data Structures	3	0	0	3	ESC
4	EE 201	Electrical Measurements & Instrumentation	3	1	0	4	PCC
5	EE 202	Circuit Theory-I	3	0	0	3	PCC
6	EE 203	Electric & Magnetic Fields	3	1	0	4	PCC
7	EC 236	Analog Electronics Lab	0	0	3	2	PCC
8	CS 236	Data Structures lab	0	0	3	2	ESC
		Total	**18**	**4**	**6**	**26**	

II - Year II - Semester

Sl. No.	Course code.	Course Title	L	T	P	Credits	CAT code
1	MA 251	Mathematics – IV	3	1	0	4	BSC
2	EC 285	Digital Electronics	3	1	0	4	PCC
3	EE 251	Circuit Theory-II	3	1	0	4	PCC
4	EE 252	Electrical Machines-I	3	1	0	4	PCC
5	EE 253	Power Systems	4	0	0	4	PCC
6	EC 286	IC Applications Lab	0	0	3	2	PCC
7	EE 254	Electrical Measurements Lab	0	0	3	2	PCC
		Total	**18**	**4**	**6**	**24**	

III - Year I – Semester

Sl.No.	Course code.	*Course Title*	L	T	P	Credits	CAT code
1	EE 301	Control Systems	3	1	0	4	PCC
2	EE 302	Electrical Machines-II	3	1	0	4	PCC
3	EE 303	Power Systems-II	3	1	0	4	PCC
4	EE 304	Electrical Machines Lab-I	0	0	4	3	PCC
5	EE 305	Circuits Lab	0	0	3	2	PCC
6	EE 306	Electrical Simulation Laboratory	0	0	3	2	PCC
7		Elective –I	3	0	0	3	DEC
8		Elective – II	3	0	0	3	DEC
		Total	**15 3 10**			**25**	

III - Year II - Semester

Sl.No.	**Course code.**	***Course Title***	**L**	**T**	**P**	**Credits**	**CAT code**
1	SM 335	Engineering Economics & Accountancy	3	0	0	3	HSC
2	EE 351	Power System Operations & Control	3	1	0	4	PCC
3	EE 352	Power Electronics	3	1	0	4	PCC
4	EE 353	Power System Protection	3	1	0	4	PCC
5	EE 354	Electrical Machines –III	3	1	0	4	PCC
6	EE 355	Control Systems Lab	0	0	3	2	PCC
7	EE 356	Electrical Machines Lab-II	0	0	3	2	PCC
8	390	Open Elective – I	3	0	0	3	OPC
		Total	**15 4 6**			**26**	

IV - Year I - Semester

Sl.No.	Course code.	*Course Title*	L	T	P	Credits	CAT code
1	ME 435	Industrial Management	3	0	0	3	ESC
1	EE 401	Solid State Drives	3	1	0	4	PCC
2	EE 402	HVDC & FACTS	3	1	0	4	PCC
3	EE 403	Elective III	3	0	0	3	DEC
4	440	Open Elective – II	3	0	0	3	OPC
5	EE 441	Seminar	0	0	3	1	PCC
6	EE 449	Project Work – Part A	0	0	3	2	PRC
		Total	**15**	**2**	**6**	**20**	

IV - Year II - Semester

Sl.No.	Course code.	*Course Title*	L	T	P	Credits	CAT code
1	EE 451	Power Systems Lab	0	0	3	2	PCC
2	EE 452	Power Electronics & Drives Lab	0	0	3	2	PCC
3		Elective – IV	3	0	0	3	DEC
4		Elective – V	3	0	0	3	DEC
5		Elective – VI	3	0	0	3	DEC
6		Elective – VII	3	0	0	3	DEC
7		Elective – VIII	3	0	0	3	DEC
8	EE 499	Project Work – Part B	0	0	6	4	PRC
		Total	**15**	**0**	**12**	**23**	

List of Electives

III Year I Semester

EE 311 Computer Organization

EE 312 Design of Electrical Systems

EE 313 Digital Signal Processing

EE 314 Electrical Engineering Materials

EE 315 Microprocessors and applications

EE 316 Utilization of Electrical Energy

III Year II Semester

Open Elective – I EE 390 Linear Control System

IV Year I Semester

EE 411 AI Techniques in Electrical Engineering

EE 412 Computer Methods in Power Systems

EE 413 Electric Traction

EE 414 Switched Mode Power Conversion

Open Elective – II EE 440 New Venture Creation

IV Year II Semester

EE 461 Distribution System Planning and Automation

EE 462 High Voltage Engineering

EE 463 Modelling and Analysis of Electrical machines

EE 464 Planning an Entrepreneurial Venture

EE 465 Power Quality

EE 466 Power System Deregulation

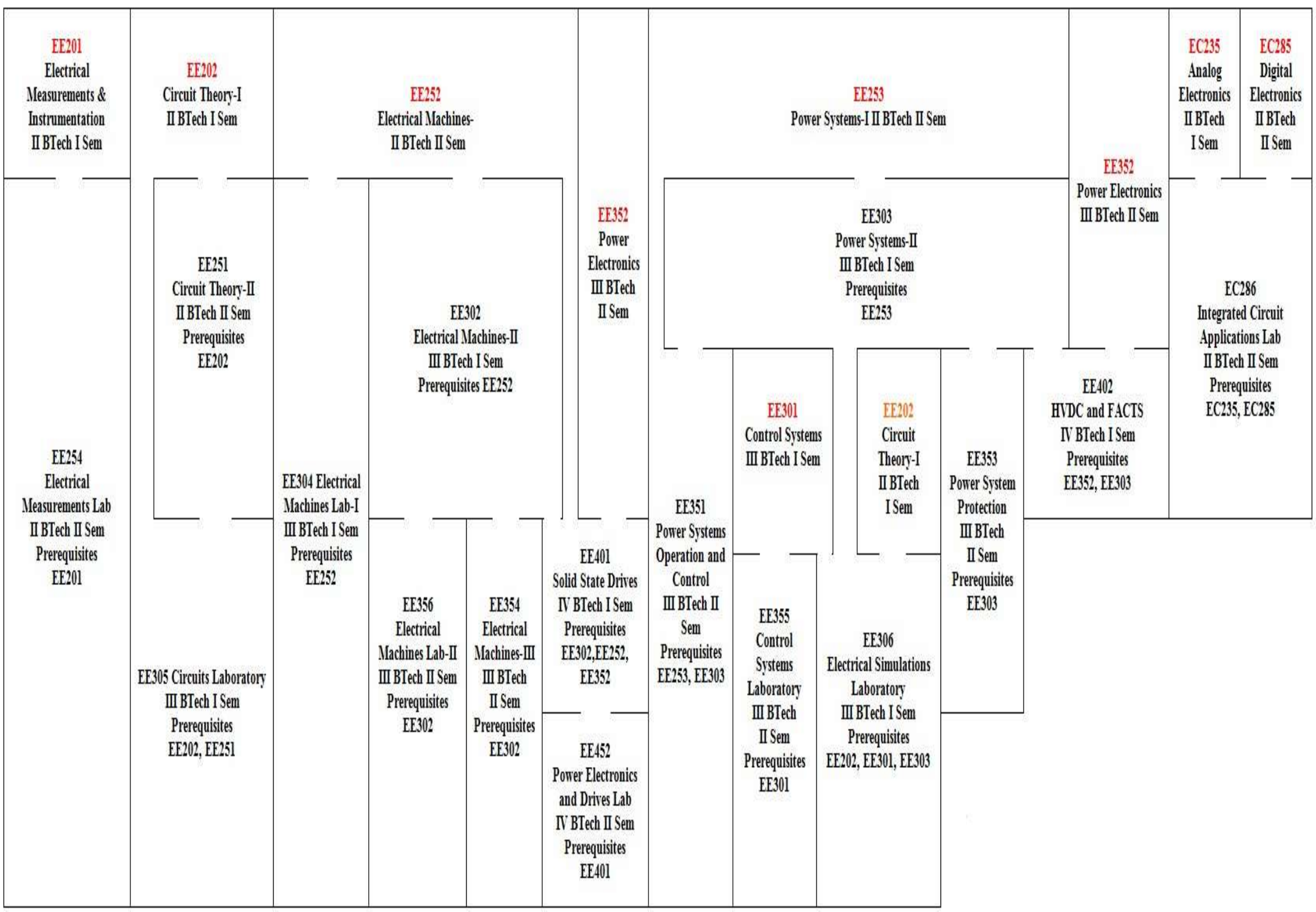
EE 467 Real Time Control of Power System

EE 468 Renewable Energy Systems

EE 469 Smart Electric Grid

B.TECH IN ELECTRICAL AND ELECTRONICS ENGINEERING

PRE-REQUISITE CHART



DETAILED SYLLABUS

MA101	MATHEMATICS – I	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Solve linear system equation
CO2	Determine the Eigen values and vectors of a matrix
CO3	Determine the power series expansion of a function
CO4	Estimate the maxima and minima of multivariable functions
CO5	Solve any given first order ordinary differential equation
CO6	Solve any higher order linear ordinary differential equation with constant coefficients

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2										
CO3	3	3								
CO4										
CO5	3	3								
CO6	1	1								

Detailed Syllabus:

Matrix Theory: Elementary row and column operations on a matrix, Rank of matrix – Normal form – Inverse of a matrix using elementary operations –Consistency and solutions of systems of linear equations using elementary operations, linear dependence and independence of vectors - Characteristic roots and vectors of a matrix - Caley-Hamillton theorem and its applications, Complex matrices, Hermitian and Unitary Matrices - Reduction to diagonal form - Reduction of a quadratic form to canonical form – orthogonal transformation and congruent transformation.

Differential Calculus: Rolle's theorem; Mean value theorem; Taylor's and Maclaurin's theorems with remainders, Expansions; Indeterminate forms; Asymptotes and curvature; Curve tracing; Functions of several variables, Partial Differentiation, Total Differentiation, Euler's theorem and generalization, maxima and minima of functions of several variables (two and three variables) – Lagrange's method of Multipliers; Change of variables – Jacobians.

Ordinary differential equations of first order: Formation of differential equations; Separable equations; equations reducible to separable form; exact equations; integrating factors; linear first order equations; Bernoulli's equation; Orthogonal trajectories and Newton's law of cooling.

Ordinary linear differential equations of higher order : Homogeneous linear equations of arbitrary order with constant coefficients - Non-homogeneous linear equations with constant coefficients; Euler and Cauchy's equations; Method of variation of parameters; System of linear differential equations, Vibrations of a beam.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8^{th} Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

HS101	ENGLISH FOR COMMUNICATION	HSC	3 – 0 – 2	4 Credits

Pre-requisites: None.

Course outcomes: At the end of the course, the student will be able to:

CO1	Understand basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sound system, stress and intonation

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2							3			
CO3							3			
CO4							3			
CO5							3			
CO6							3			

Detailed syllabus

Grammar Principles and Vocabulary Building: -Exposure to basics of grammar- parts of speech, with emphasis on tenses—active and passive voice- their usage- reported speech - Idioms and Phrases—their meanings and usage, Vocabulary development through prefixes, suffixes and word roots

Effective Sentence Construction –clarity and precision in construction—strategies for effectiveness in writing

Paragraphs: Definition- structure- Types and Composition-unity of theme- coherence- organisation patterns

Note-making – its uses- steps in note-making—identification of important points-reduction to phrases –selection of suitable note format- types of notes—tree diagram, block list, table-

Letter Writing: Business, Official and Informal letters-- communicative purpose-strategy-letter format and mechanics- letters of request , complaint and invitation-

Reading techniques: Skimming and Scanning – quick reading for gist and –suggesting titles-looking for specific information

Description of Graphics- kinds of graphs- their construction and use and application in scientific texts- interpretation of graphs using expressions of comparison and contrast

Reading Comprehension – reading to retrieve information ––techniques of comprehension -find clues to locate important points- answering objective type questions –inference, elimination

Technical Report-Writing - kinds of reports-proposals, progress and final reports- their structure- features- process of writing a report-editing

Book Reviews- Oral and written review of a chosen novel/play- a brief written analysis including summary and appreciation- oral presentation of the novel before class

Reading

1. A Textbook of English for Engineers and Technologists (combined edition, Vol. 1 & 2); Orient Black Swan 2010.

PH101	PHYSICS	BSC	4 – 0 – 0	4 Credits

Prerequisites: None.

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

CO1	Solve engineering problems using the concepts of wave and particle nature of radiant energy
CO2	Understand the use of lasers as light sources for low and high energy applications
CO3	Understand the nature and characterization of acoustic design, nuclear accelerators and new materials
CO4	Apply the concepts of light in optical fibers, light wave communication systems, and holography and for sensing physical parameters
CO5	Construct a quantum mechanical model to explain the behaviour of a system at microscopic level

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3						
CO2	3	3						
CO3	3	3						
CO4	3	3						
CO5	3	3						

Detailed Syllabus:

Interference: Superposition principle, Division of amplitude and wave front division, Interferometers (Michelson, Fabry-Perot, Mach-Zehnder), Applications; Diffraction: Fraunhoffer diffraction (single, double & multiple slits), Resolving power, Dispersive power, Applications.

Polarization: Production & detection of polarized light, wave plates, optical activity, Laurents Half-shade polarimeter, photoelasticity and applications; LASERS: Basic principles of Lasers, He-Ne, Nd-YAG, CO_2 and semiconductors lasers, applications of lasers, Holography and holographic NDT.

Optical fibers: Light propagation in Optical fibers, types of optical fibers, optical fibers for communication and sensing.

Functional materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, biomaterials, high temperature materials, smart materials and their applications, Introduction to Nano materials.

Modern physics: Qualitative review of different experiments, de-Broglie waves, Dual nature of matter, Schrodinger wave equation, wave function and its interpretation, potential well problems in one dimension, Tunneling, Uncertainty principle, Particle Accelerators: Cyclotron, Synchro Cyclotron, Betatron and applications.

Acoustics: Introduction, Reverberation and reverberation time, growth and decay of energy, Sabine's formula, absorption coefficient and its measurement, factors affecting architectural acoustics; Production, detection and applications of Ultrasound.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, 9th Ed.,John Wiley, 2011.
2. Beiser A, Concepts of Modern Physics, 5th Ed., McGraw Hill International, 2003.
3. Ajoy Ghatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
4. M. Armugam, Engineering Physics, Anuradha Agencies, 2003.

CY101	CHEMISTRY	BSC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Understand and apply the concepts in electrochemistry and corrosion science
CO2	Understand the concepts in molecular interactions
CO3	Understand the synthesis and analysis of modern materials
CO4	Apply the concepts of organic chemistry for synthesis
CO5	Understand the synthesis and applications of polymer science
CO6	Identify the structure of organic molecules using photo chemistry and chemical spectroscopy

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5	3	3								
CO6	3	3								

Detailed Syllabus:

Electrochemistry - Review of the concepts of electrode potentials, Nernst equation, Reference electrodes, Ion selective electrodes – Concept – Glass electrode – Determination of pH of a solution using a glass electrode – Derivation of equation between E_{cell} and pH, Determination of F^- ion using fluoride electrode (Numerical calculations), Chemically modified electrodes (CMEs) – Concept, CMEs as potentiometric and amperometric sensors, Electrochemical energy systems, Electrochemistry of secondary cells e.g. Lead – acid and Ni-Cd cells, Rechargeable lithium batteries, Fuel cells – Electrochemistry of a H_2–O_2 fuel cell, methanol–O_2 fuel cell.

Corrosion and Its Prevention - Electrochemical theory of corrosion, Corrosion due to dissimilar metal cells (galvanic cells), Corrosion due to differential aeration cells, Uniform corrosion, pitting corrosion and stress corrosion cracking, Effect of pH, Potential-pH diagram for Iron, temperature and dissolved oxygen on corrosion rate, Corrosion prevention and control by cathodic protection.

Molecular Interactions - Molecular orbital theory applicable to understanding of bonding in heteronuclear diatomic molecules, e.g. CO and NO, Molecular orbital energy diagram of an Octahedral complex, MO diagram of a molecule involving charge transfer (e.g. $KMnO_4$), Nature of supramolecular interactions: ion-ion interactions, ion-dipole interactions, dipole-dipole interactions, hydrogen bonding, cation-л interactions, л-л interactions, van der Walls forces, Concept of self-assembly involving different types of interactions (Micellar formation; Membrane Formation; Surface films).

Chemistry of Nanomaterials - Introduction to Nanomaterials, Chemical synthesis of nanomaterials: sol-gel method, Reverse micellar method, electrolytic method, Characterization of nanoparticles by BET method, Characterization of nanomaterials by TEM (includes basic principle of TEM), Applications of nanomaterials in Industry as drug delivery materials, as catalysts, in water treatment.

Basic Principles Of Organic Chemistry – Introduction, Homolytic and Heterolytic cleavages and free radicals Carbocations, carbanions and addition reactions Elimination and substitution reactions.

Stereochemistry: chirality, optical activity, enantiomers and diastereomers, Projection formulae and geometrical isomerism, Reactions - Hofmann reaction and Riemer-Tiemann reaction, Diels-Alder reaction and Cannizaro reaction, Skraup synthesis.

Polymer Chemistry - Concept of polymerization – Types of polymerization, Chain growth polymerization – mechanisms of free radical and cationic polymerizations, Mechanisms of simple anionic polymerization and co-ordination anionic polymerization (complex forming mechanism), Step-growth polymerization ,Mechanism and examples.

Thermoplastic resins and Thermosetting resins- examples and applications, conducting polymers: Mechanism of conduction in polymers – Examples – and applications.

Review Of Chemical Spectroscopy - Review of electromagnetic spectrum, Quantization of energy, Born – Oppenheimer approximation, Frank Condon Principle Vibrational spectra (Infra-red) of diatomic molecules – Selection rules Determination of force constant Problems, Identification of functional groups using IR spectroscopy Electronic spectroscopy - Types of electronic transitions –calculation of chromophoric absorptions For Diene and ene-one chromophors Qualitative analysis by electronic spectroscopy, Lambert – Beer's law-Applications in Quantitative analysis and problems.

NMR spectroscopy: Basic principles, Concept of chemical shift. Concept of spin-spin splitting and examples, Applications of UV,I.R and ^1H NMR spectra in the determination of structures of Ethyl alcohol, Dimethyl ether, Acetic acid and Benzyl alcohol.

Photo Chemistry – Principles of photochemistry – Rates of intermolecular processes, Jablonski diagram – fluorescence, phosphorescene and Chemiluminescence, Types of Photochemical

Organic reactions, Laws of photochemistry and quantum yields-problems, Photosensitized reactions.

Reading:

1. P. W. Atkins & Julio de Paula, Atkins Physical Chemistryl Chemistry, Oxford University Press York, 7th Edn, 2002.
2. Shashi Chawla, A Text Book of Engineering Chemistry, 3rd Edition, Dhanpat Rai & Co New Delhi, 2007.
3. S. Vairam, P. Kalyani & Suba Ramesh, Engineering Chemistry, Ist Edn, John Wiley & Sons, India, 2011.
4. Lee J.D., Concise Inorganic Chemistry, 7th Edn, Blackwel Science Publications Oxford, London, 2004.
5. Jerry March., Advanced Organic Chemistry, 6th Edn, John Wiley & Sons, New Jersy, 2007.
6. FehFuYen, Chemistry for Engineers, Imperial College Press, 2008.
7. Octave Levenspiel, Chemical Reaction Engineering, 2nd Edition, Wiley India, 2006.
8. Smith J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.

EC101	BASIC ELECTRONICS ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Characterize semiconductors, diodes, transistors and operational amplifiers
CO2	Design simple analog circuits
CO3	Design simple combinational and sequential logic circuits
CO4	Understand functions of digital multimeter, cathode ray oscilloscope and transducers in the measurement of physical variables
CO5	Understand fundamental principles of radio communication

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5										

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. Cascaded amplifiers, FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive feedback merits and demerits, Principle of oscillators, LC and RC oscillators.

Integrated Circuits: Operational amplifiers, Applications: adder, subtractor, Integrator and Differentiators.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's).

Electronic Instrumentation: Measurement, Sensors, Laboratory measuring instruments: digital multi-meters and Cathode Ray Oscilloscopes (CRO's).

Principles of Communication: Need for Modulation, Modulation and Demodulation techniques.

Reading:

1. Neil Storey, "Electronics A Systems Approach", 4/e - Pearson Education Publishing Company Pvt Ltd, 2011.
2. Salivahanan, N Suresh Kumar, "Electronic Devices and Circuits" 3/e, McGraw Hill Publications, 2013.
3. Bhargava N. N., D C Kulshreshtha and S C Gupta, "Basic Electronics & Linear Circuits", Tata McGraw Hill, 2/e, 2013 .

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	3							
CO2	2	1	3							
CO3		1	2	1						
CO4	1	1	1	1						

Detailed Syllabus:

DC Circuits: Kirchhoff's Voltage & Current laws, Superposition Theorem, Star – Delta Transformations.

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of Single Phase Series & Parallel Circuits. Solution of Three Phase circuits and Measurement of Power in Three Phase circuits.

Magnetic Circuits: Fundamentals and Solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling.

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF equation, Phasor diagram, Equivalent Circuit, Determination of Equivalent Circuit Parameters, Regulation and Efficiency of a single phase transformer. Principle of operation of an Auto Transformer.

DC Machines: Principle of Operation, Classification, EMF and Torque equations, Characteristics of Generators and Motors, Speed Control Methods and Starting Techniques.

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-φ I.M., Torque-Speed Characteristics of 3-φ I.M., Starting Methods and Applications of Three Phase Induction Motors.

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters, Dynamometer Type Wattmeter and Induction Type Energy Meter.

Reading:

1. Edward Hughes, Electrical Technology, 10th Edition, ELBS, 2010.
2. Vincent Del Toro, Electrical Engineering Fundamentals, 2nd Edition, PHI, 2003.
3. V.N. Mittle, Basic Electrical Engineering, TMH, 2000.

CE101	ENGINEERING MECHANICS	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5										

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid & M.I – Arial & Mass M.I – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Direct Central Impact – coefficient of restitution, Curvilinear Motion – Projectile Motion, Work & Energy in Curvilinear motion.

Dynamics of Rigid Bodies - Rigid body rotation – Kinematics - Kinetics, Problems – Work & Energy in Rigid body rotation, Plane Motion – Kinematics, Problem – Instantaneous center of rotation.

Reading:

1. J.L.Meriam and L.G. Kraige, Engineering Mechanics, 7th Ed, John Wiley & Sons, 2012.
2. Timoshenko and Young, Engineering Mechanics, 3rd Ed, McGraw Hill Publishers, 2006.
3. Gere and Timoshenko, Mechanics of Materials, 2nd Ed, CBS Publishers, 2011.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyse material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Mapping of Course Outcomes(COs) and the Program Outcomes(POs)

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1								3	3	
CO2								3	3	
CO3								3	3	
CO4								3	3	

Detailed Syllabus:

Nature and scope of Environmental Problems: Environment and society, environmental disturbances, role of technology, sustainable development, quantification of environmental issues.

Population and Economic growth: Economic growth and industrialization urbanization, Resource consumption, Renewable and nonrenewable resources, Energy requirement and development.

Global Atmospheric systems: Concept of climate change, green house effect, global energy balance, global warming, carbon cycle, Intergovernmental Panel for Climate Change (IPCC) emission scenarios, impact of climate change.

Mass balance and Environmental chemistry: Mass and Energy balance, Particle dispersion, oxygen demand, carbon emission, enthalpy in environmental systems, chemical equilibria.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: water pollutants, effects of oxygen demanding waste on water, water quality in lakes, reservoirs and groundwater, contaminant transport, self cleaning capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Overview of emissions, pollutant standard index, toxic air pollutants, vehicle emissions, indoor air quality, principles of air pollution control.

Solid and Hazardous Waste: Characteristics of Solid and Hazardous Waste, Collection and transfer system, recycling, composting, waste to energy conversion, landfills.

Environmental Management: Sustainable development, Environmental Impact Assessment (EIA), Environmental Ethics, Legal aspects.

Reading:

1. J.G. Henry and G.W. Heinke, Environmental Science and Engineering, Pearson Education, 2004
2. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2004.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand basics of thermodynamics and components of a thermal power plant
CO2	Identify engineering materials, their properties, manufacturing methods encountered in engineering practice
CO3	Understand basics of heat transfer, refrigeration and internal combustion engines
CO4	Understand mechanism of power transfer through belt, rope, chain and gear drives
CO5	Understand functions and operations of machine tools including milling, shaping, grinding and lathe machines

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5	3	3								

Detailed Syllabus:

Introduction: Introduction to Thermodynamics - Concept of a System – Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and Cycle, Zeroth Law, Energy Interactions - Heat and Work, Types of Work, Work interactions in a closed System for various processes

First and Second Laws of Thermodynamics: First Law: Cycle and Process, Specific Heats (c_p and c_v), Heat interactions in a Closed System for various processes, Limitations of First Law, Concept of Heat Engine (H.E.) and Reversed H.E. (Heat Pump and Refrigerator), Efficiency/COP, Second Law: Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, Statement of Clausius Inequality, Property of Entropy, T-S and P-V Diagrams

Thermal Power Plant: Thermal Power Plant Layout – Four Circuits, Rankine Cycle, Boilers: Fire Tube vs Water Tube; Babcock & Wilcox, Cochran Boilers, Steam Turbines : Impulse vs Reaction Turbines, Compounding of Turbines: Pressure Compounding, Velocity Compounding, Pressure-Velocity Compounding, Condensers: Types – Jet & Surface Condensers, Cooling Towers

Manufacturing Processes: Engineering Materials: Classification, Properties of Materials, Manufacturing Processes: Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing

Internal Combustion Engines and Refrigeration: IC Engines: 2 - Stroke and 4 - Stroke Engines, S.I. Engine and C.I. Engine: Differences, P-V and T-S Diagrams

Refrigeration System and Refrigerants: Principle and working of standard vapor compression refrigeration system and Brief description of Refrigerants

Heat Transfer: Heat Transfer: Modes; Thermal Resistance Concept, Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Simple Numerical Problems: Heat Transfer

Welding: Welding: Gas Welding and Arc Welding, Soldering, Brazing

Power Transmission: Transmission of Mechanical Power: Belt Drives – Simple Numerical Problems, Gear Drives – Simple Numerical Problems

Basics of Automotive Vehicle: Lay out of Automobile Transmission; Brakes – Types, Clutch, Differential

Machine Tools and Machining Processes: Machine Tools Machine Tools: Lathe Machine, Lathe Operations, Milling Machine-Types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

Reading:

1. Mathur, M.L., Mehta, F.S., and Tiwari, R.P., Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2011.
2. Roy, K.P., and Hazra Chowdary, S.K.., Elements of Mechanical Engineering, Media Promoters and Publishers Pvt. Ltd., 2002.
3. Rudramoorthy, R.., Thermal Engineering, Tata McGraw Hill Book Company, New Delhi, 2003.
4. Hazra Chowdary., S.K. and Bose, Workshop Technology, Vol. I and II, Media Promoters and Publishers Pvt. Ltd., 2002.

ME102	ENGINEERING GRAPHICS	ESC	2 – 0 – 3	4 Credits

Pre-requisites: None.

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

CO1	Draw Orthographic projections of Lines, Planes, and Solids
CO2	Construct Isometric Scale, Isometric Projections and Views
CO3	Draw Sections of various Solids including Cylinders, cones, prisms and pyramids
CO4	Draw projections of lines, planes, solids, isometric projections and sections of solids including Cylinders, cones, prisms and pyramids using AutoCAD

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								

Detailed Syllabus:

Introduction: Overview of the course, Examination and Evaluation patterns.

Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales.

Orthographic projection of points: Principles of Orthographic projection, Projections of points.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES tool bar, Standard Tool bar, LAYERS

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers 2013
2. E. Finkelstein, “AutoCAD 2007 Bible”, Wiley Publishing Inc., 2007

CS101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ESC	4 – 0 – 0	4 Credits

Pre-requisites: None.

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

CO1	Develop algorithms for mathematical and scientific problems
CO2	Explore alternate algorithmic approaches to problem solving
CO3	Understand the components of computing systems
CO4	Choose data types and structures to solve mathematical and scientific problem
CO5	Develop modular programs using control structures
CO6	Write programs to solve real world problems using object oriented features

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5	3	3								
CO6	3	3								

Detailed Syllabus:

Problem solving techniques – algorithms.

Introduction to computers - Basics of C++ - Number representation, Basic data types - int, float, double, char, bool, void.

Flow of Control - Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions - user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion.

Arrays - Single, Multi-Dimensional Arrays, initialization, accessing individual elements, passing arrays as parameters to functions.

Pointers and Dynamic Arrays - Multidimensional Dynamic Arrays, creation and deletion of single and multi-dimensional arrays.

C Strings, Standard String Class

I/O Streams, stream flags, stream manipulators, formatted I/O, binary I/O, Character I/O, File I/O - Opening, closing and editing files.

Structures and Classes - Declaration, member variables, member functions, access modifiers, inheritance, function overloading, overriding, redefinition, virtual functions, operator overloading, polymorphism - compile time and runtime binding.

Reading:

1. Walter Savitch, Problem Solving with C++, Sixth Edition, Pearson, 2007.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, Indian Edition, 2006.

PH102	PHYSICS LABORATORY	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3		3	
CO2							3		3	
CO3							3		3	
CO4							3			

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

CY102	CHEMISTRY LABORATORY	BSC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Synthesize polymers
CO2	Analyze ores and bleaching powder
CO3	Estimate the Hardness of water in terms of Calcium and Magnesium ions
CO4	Determine salt content using chromatographic techniques
CO5	Standardize solutions using titration, conductivity meter, pH-meter, potentiometer and colorimeter
CO6	Verify the Freundlich adsorption isotherm

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3		3	
CO2							3		3	
CO3							3		3	
CO4							3		3	
CO5							3		3	
CO6							3		3	

Detailed Syllabus:

Cycle 1

1. Standardization of potassium permanganate.
2. Determination of MnO2 in Pyrolusite.
3. Determination of Iron in Haematite.
4. Determination of available Chlorine in bleaching powder and of Iodine in Iodized salt.
5. Determination of hardness of water and of calcium in milk powder.
6. Chemistry of blue printing.
7. Preparation of phenol formaldehyde resin.

Cycle 2

1. Conductometric titration of an Acid vs Base.
2. pH-metric titration of an Acid vs Base.
3. Potentiometric titration of Fe^{2+} against $K_2Cr_2O_7$.
4. Colorimetric titration of potassium permanganate.
5. Determination of rate of corrosion of mild steel in acidic environment in the absence and presence of an inhibitor.
6. Determination of salt content by Ion-exchange.
7. Separation of Ions by paper chromatography.
8. Verification of Freundlich adsorption isotherm.

Reading:

1. Valentin, W. G. "A Course of Qualitative Chemical Analysis" Read Books Design, 2010; ISBN: 1446022730, 9781446022733.
2. G. Svehla: Vogel's Qualitative Inorganic Analysis. J. Mendham, R. C. Denny, J. D. Barnes, M. J. K. Thomas: Vogel's Text Book of Quantitative Chemical Analysis.
3. G. N. Mukherjee: Semi-Micro Qualitative Inorganic Analysis (CU Publications) Vogel's Text Book of Practical Organic Chemistry (5th Edition).
4. N. G. Mukherjee: Selected Experiments in Physical Chemistry.

CS102	PROBLEM SOLVING AND COMPUTER PROGRAMMING LABORATORY	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3		3	
CO2							3		3	
CO3							3		3	
CO4							3		3	

Detailed Syllabus:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.
8. Programs on inheritance and polymorphism.

Reading:

1. Walter Savitch, Problem Solving with C++, 6th Edition, Pearson, 2008.
2. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

ME103	WORKSHOP PRACTICE	ESC	0 – 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3		3	
CO2							3		3	
CO3							3		3	
CO4							3		3	

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint

House Wiring: Introduction to House wiring, different types of cables. Types of power supply, types of motors, Starters, distribution of power supply, types of bulbs, parts of tube light, Electrical wiring symbols, Stair case wiring: Demo and Practice (2 switches with one lamp control) and Godown wiring

Foundry Trade: Introduction to foundry, Patterns, pattern allowances, ingredients of moulding sand and melting furnaces. Foundry tools and their purposes, Demo of mould preparation and Practice – Preparation of mould by using split pattern.

Welding: Introduction, Study of Tools and welding Equipment (Gas and Arc welding), Selection of welding electrode and current, Bead practice and Practice of Butt Joint, Lap Joint.

Reading:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. Jeyapoovan T.and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008.

MA151	MATHEMATICS – II	BSC	4 – 0 – 0	4 Credits

Prerequisites: Mathematics – I.

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

CO1	Solve linear differential equations using Laplace transforms
CO2	Evaluate multiple integrals and improper integrals
CO3	Convert line integrals to area integrals
CO4	Convert surface integrals to volume integrals
CO5	Determine potential functions for irrotational force fields

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								
CO5	3	3								

Detailed Syllabus:

Laplace Transformation: Laplace transform - Inverse Laplace transform - properties of Laplace transforms - Laplace transforms of unit step function, impulse function and periodic function - convolution theorem - Solution of ordinary differential equations with constant coefficients and system of linear differential equations with constant coefficients using Laplace transform.

Integral Calculus: Fundamental theorem of integral calculus and mean value theorems; Evaluation of plane areas, volume and surface area of a solid of revolution and lengths. Convergence of Improper integrals – Beta and Gamma integrals – Elementary properties – Differentiation under integral sign. Double and triple integrals – computation of surface areas and volumes – change of variables in double and triple integrals.

Vector Calculus : Scalar and Vector fields; Vector Differentiation; Level surfaces - directional derivative - Gradient of scalar field; Divergence and Curl of a vector field - Laplacian - Line and surface integrals; Green's theorem in plane; Gauss Divergence theorem; Stokes' theorem.

Reading:

1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, 2008.
2. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

MA201	MATHEMATICS-III	BSC	3– 1–0	4 Credits

Pre-requisites: MA151- Mathematics-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply z-transform to solve linear difference equations.
CO2	Evaluate Fourier series and transform
CO3	Understand and use complex variables and functions integrals.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-

Detailed syllabus

FOURIER SERIES

Introduction, Dirichlet Conditions, Fourier Series and its Coefficients for a given range, Even, odd functions and Fourier Series, Half-range Series, problems, Parseval Identity, Complex form of Fourier Series.

FOURIER TRANSFORMS

Fourier Integral representation, Fourier integrals, Fourier transforms, Sine, Cosine transforms, inverse transforms, Illustrations, Properties, Parseval Identity, evaluation of certain real integrals.

Z-T RANSFORMS

Z-transforms – illustrations and properties, initial and final value theorems, Convolution theorem, Inverse z-transforms, solution of difference equations using z-transforms.

PARTIAL DIFFERENTIAL EQUATIONS

Introduction, method of separation of variables, Solution of wave equation – vibration of strings, solution of heat equation – one dimensional unsteady heat flow, steady-state conditions but with zero boundary conditions, one end insulated & the other end with zero temperature, Laplace Equation – two dimensional steady-state heat flow, infinitely long plates, finite plates at most two insulated edges, Laplace Equation – in polar form.

COMPLEX VARIABLES

Introduction, analytic functions, CR equations, harmonic functions, harmonic conjugate, properties, complex integration – line integrals in complex plane, Cauchy’s theorem (with simple proof), Cauchy’s theorem for multiple connected domains, Cauchy’s integral formula, Taylor’s and Laurent’s theorems, series expansions, Zeros and singularities, classification, Residues, Residue Theorem, Evaluation of real integrals using residue theorem –3 types of integrals, conformal mapping, elementary transformations, examples, Bilinear transformations, cross ratios, problems.

Reading:

1. R. K. Jain & S. R. K. Iyengar: Advanced Engineering Mathematics, Narosa Publishing House, 2008
2. Erwyn Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition.
3. B. S. Grewal: Higher Engineering Mathematics, Khanna Publications, 2009.

EC235	ANALOG ELECTRONICS	PCC	3– 1– 0	4 Credits

Pre-requisites: EC101-Basic Electronics Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand operation of analog devices and circuits.
CO2	Examine the operation of oscillators and amplifiers.
CO3	Design multi-vibrators and wave shaping circuits

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3	3				3		
CO2	3	3		2					3	3
CO3	3	3		3	2				3	3

Detailed syllabus

OVER VIEW OF SEMI CONDUCTOR PHYSICS
Introduction, static characteristics of PN-Junction diode, zener diode, BJT, FET and MOSFETs

POWER SUPPLIES
Single phase half wave, full wave and bridge rectifiers with filters (LC and π), Regulated power supply, series voltage regulator, principles of uninterrupted power supply

TRANSISTOR AMPLIFIERS
Bias stability and thermal runway, analysis of amplifier circuits using h-parameters, emitter follower, simplified CE hybrid model, CE short circuit current gain, single stage CE amplifier response, low frequency response of an RC coupled amplifier, gain-band width product, high frequency response of two cascaded CE stages.

FEEDBACK AMPLIFIERS AND OSCILLATORS
Analysis of voltage series, voltage shunt, current series, current shunt, feedback amplifiers, stability of negative feedback amplifiers, analysis of RC phase-shift, Wien bridge, LC-oscillators (using BJT's only) and crystal oscillators.

DIRECT COUPLED AMPLIFIERS
Analysis of differential amplifier configurations, CMRR, stability and drift problems, compensation techniques

POWER AMPLIFIERS
Classification of power amplifiers, analysis of class-A, class-B and class-AB operations, push-pull amplifiers and complementary symmetry, harmonic distortion, and cross-over distortion in power amplifiers

WAVE SHAPING CIRCUITS
RC-low pass, high pass circuits, response to step, pulse ramp and square wave inputs, differentiating and integrating circuits, clipping circuits using diodes-single level and two-level clipping, clamping circuits using diodes.

MULTIVIBRATORS AND SWEEP CIRCUITS
Introduction to voltage sweep circuits, boot strap and miller sweep circuits, Astable and Monostable Multi-vibrators and Triggering methods.

Reading:

1. Ramakanth A. Gayakwad: Operational Amplifiers and Linear integrated circuits, Edition 4, PHI, 2000.
2. *Stanley: Operational Amplifiers with Linear Integrated Circuits, Edition 4, Pearson Education India, 2002.*
3. U. A. Bakshi, A. P. Godse: Linear integrated, Technical Publications, 2010.

CS235	DATA STRUCTURES	ESC	3–0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the concept of ADT
CO2	Identify data structures suitable to solve problems
CO3	Develop and analyze algorithms for stacks, queues
CO4	Develop algorithms for binary trees and graphs
CO5	Implement sorting and searching algorithms
CO6	Implement symbol table using hashing techniques

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	--	-	-
CO6	3	3	-	-	-	-	-	-	-	-

Detailed syllabus

Introduction to Data Structures, Asymptotic Notations, Theorems and Examples based on Asymptotic Notations, Linear and Non linear Data Structures, Stack Data Structure and its Applications, Queue Data Structure and its Applications, Singly, Doubly and Circular Linked Lists, Trees and tree traversals, Dynamic Sets and Operations on Dynamic Sets, Binary Search Tree and its Operations, Heap Data Structure, Priority Queue, AVL Trees, Direct Addressing; Introduction to Hashing, Collision Resolution by Chaining, Collision Resolution by Open Addressing, Lower Bound for Comparison based Sorting Algorithms, Insertion Sort, Merge Sort, Quick Sort, Heap Sort and Counting Sort, Radix Sort, Introduction to Graphs and Representation of Graphs, Depth First Search (DFS), Breadth First Search (BFS), Applications: BFS and DFS, Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths, Floydd-Warshall Algorithm for All-Pairs Shortest Path Problem

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, PHI, 2009.
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Third Edition, Pearson Education, 2006

3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press, 2011.
4. Michael T.Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley-India, 2006

EE201	ELECTRICAL MEASUREMENTS AND INSTRUMENTATION	PCC	3–1– 0	4 Credits

Pre-requisites: EE101, EC101, PH101, MA102

Course Outcomes: At the end of the course the student will be able to:

CO1	Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO
CO2	Determine the circuit parameters using AC and DC bridges
CO3	Compute the errors in CTs and PTs
CO4	Select transducers for the measurement of temperature, displacement and strain
CO5	Understand operating principles of electronic measuring instruments

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	2	3	-	-	--	-	-
CO2	-	-	-	3	-	-	3	-	-	-
CO3	3	3	-	3	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	-	-	-
CO5	-	-	3	2	3	-	-	-		3

Detailed syllabus

Analog Ammeters and Voltmeters
PMMC and MI Instruments, Construction, Torque Equation, Range Extension, Effect of temperature, Classification, Errors, Advantages and Disadvantages.

Analog Wattmeters and Power Factor Meters
Power and Power Factor, Electrodynamometer type wattmeter, power factor meter, Construction, theory, Shape of scale, torque equation, Advantages and disadvantages, active and reactive power measurement in single phase, Measurement in three phase.

Analog Energy Meter
Single phase induction type energy meters, construction, theory, Operation, lag adjustments, Max Demand meters/indicators, Measurement of VAH and VARh.

DC and AC Bridges
Measurement of resistance, Wheatstone Bridge, Kelvin's Bridge, Kelvin's Double Bridge, Measurement of inductance, Capacitance, Maxwell's Bridge, Desauty Bridge, Anderson Bridge, Schering Bridge, Wien Bridge, Applications and Limitations.

Instrument Transformers

Current Transformer and Potential Transformer - construction, theory, phasor diagram, errors, testing and applications.

Transducers

Measurement of Temperature, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors.

Electronic Instruments

Electronic Display Device, Digital Voltmeters, CRO, measurement of voltage and frequency, Lissajous Patterns, Plotting B-H curve of a magnetic material, Wave Analyzers, Harmonic Distortion Analyzer.

Reading:

. J. B. Gupta: A course in Electrical and Electronic Measurements and Instrumentation, 13/E, Kataria and Sons, 2009.
2. U. A. Bakshi, A. V. Bakshi: Electrical Measurements and Instrumentation, Technical Publications, 2009.
3. A. K. Sawhney: A course in Electrical Measurements Electronic Measurements Instrumentation, Edition 11, Dhanpat Rai and Sons, 1996.
4. W.D. Coopers and Helfrick, Modern Electronic instrumentation and Measurements Techniques, Prentice Hall of India Pvt. Ltd, 2002.
5. E.W. Gowlding and F.C.Widdis, Electrical Measurements and Measuring Instruments 5/e, Wheeler Publications 1998.

EE202	CIRCUIT THEORY-I	PCC	3– 0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate steady state and transient behaviour of single port networks for DC and AC excitations.
CO2	Examine behaviour of linear circuits using Laplace transform and transfer functions of single port and two port networks
CO3	Analyze series and parallel resonant circuits.
CO4	Synthesize waveforms using step, ramp and impulse functions.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	3	-	-	-	-	-	-
CO2	3	1	1	3	-	-	3	-	-	-
CO3	3	--	-	-	-	-	-	-	-	3
CO4	3	-	3	3	-	3	-	-	-	3

Detailed syllabus

Circuit Elements and Relations
Types of Sources and Source Transformations, Dot convention, Formation of loop and node equations, Graph of a network – Incidence matrix, Cut set and Tie set matrices & Formation of equilibrium equations, Dual networks.

Steady State Analysis of Circuits for Sinusoidal Excitations
Single phase Series, Parallel, Series –Parallel circuits, Solution of AC networks using mesh and nodal analysis, 3-phase balanced and unbalanced network analysis, Neutral voltage calculations, complex power

Time Domain Analysis
Solution of network equations in time domain, Classical differential equations approach, Initial conditions & evaluation, applications to simple RLC circuits only.

Applications of Laplace Transforms in Circuit Theory
Laplace transforms of various signals of excitation, Laplace transformed networks, determination and representation of initial conditions, Waveform synthesis, Response for impulse function and its relation to network admittance, Convolution integral and applications.

Resonance
Series and Parallel resonance, Bandwidth, Q factors

Reading:

1. M.E. Van Valken Burg: Network Analysis, 3rd Edition, Pearson Education, 2006.
2. G.K Mittal & Ravi Mittal: Network Analysis, 14thEdition, Khanna Publns., 2003.
3. M.L. Soni and J.C. Gupta: A course in Electrical Circuits Analysis, Dhanpat Rai & Co. (P), 2001.
4. Gopal G. Bhise & Prem R Chodha: Engineering Network Analysis; Umesh Pub.
5. S.R. Paranjothi: Electric Circuit Analysis, New Age International Pub., 2002.
6. De Carlo & Lin: Linear circuit Analysis, Oxford University Press, 2/e, 2010.

EE203	Electric and Magnetic Fields	PCC	3–1– 0	4 Credits

Pre-requisites: MA151

Course Outcomes: At the end of the course the student will be able to:

CO1	Compute electric and magnetic fields for symmetrical charge and current configurations
CO2	Determine voltage gradients for simple charge and current configurations and the force between charges and currents.
CO3	Calculate capacitance and inductance of common conductor configurations and the energy stored.
CO4	Examine time varying fields for torque developed, emf induced and energy stored

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	-	1	-	-	-	-	-
CO2	2	2		1		-	-	-	-	-
CO3	2	2	-	1	1	-	-	-	-	-
CO4	2	2	3	1	-	-	-	-	-	-

Detailed syllabus

Electrostatics

Coulomb's law, electric field intensity, electric flux density, Gauss' law, Electric potential, electric dipole, Poisson's and Laplace' equations, Uniqueness theorem, resistance, capacitance, dielectrics, energy in electrostatic fields, boundary conditions.

Magnetostatics

Biot-Savart's law, magnetic flux density, magnetic field intensity, Ampere's Law, magnetic potential, magnetic dipole, Inductance, conductors, magnetic materials, Hall effect, energy in magneto-static fields, boundary conditions.

Time Varying Fields

Equation of continuity, Faraday's law, Lenz's law, transformer emf and motional emf, Inconsistency in Ampere's law, displacement current, Maxwell's equations, Electromagnetic wave, Poynting theorem, energy in electro-magnetic fields.

Reading:

1. William H.Hayt Jr. & John A.Buck: Engg. Electromagnetics, TMH 7th ed. 2006.
2. K. K. Shah: Introduction to electromagnetics-Dhanpat Rai 2006.
3. Matthew Sadiku: Elements of Electromagnetics, Oxford University Press, 2007.
4. Ashutosh Pramanik: Electromagnetics, Theory & Applications, PHI 2006.
5. Nathan Ida: Engg. Electromagnetics, Springer 2nd ed. 2005
6. David J.Griffiths: Introduction to Electrodynamics, PHI 2nd ed. 1995.

EC236	**Analog Electronics Lab** **L:3 T:0 P:0 C:3**	**PCC**	**3– 0– 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Test electronic circuits using experiment boards.
CO2	Design electronic circuits to meet sPCCific requirements.
CO3	Understand methods of designing electronic circuits

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	-	3	2	3	-	3	-	-	-
CO2	3	3	3	2	2	-	3	-	-	-
CO3	3	3	3	3	3	-	3	-	-	-

Detailed syllabus

List of Experiments:

1. Characteristics of Semiconductor devices: Diode, BJT, FET.
2. Transistor biasing
3. Zener diode as a regulator
4. Frequency Response of single stage CE amplifier.
5. RC Phase shift Oscillator
6. OPAMP IC 741 Inverting and non-inverting amplifiers.
7. Clippers and Clampers
8. Rectifiers and Filters
9. OPAMP 741 Logarithmic Amplifier
10. Multi-vibrators

Reading:

1. J. MILLMAN, Microelectronics, Mc grawhill, 1987.
2. RAMAKANT A. GAYAKWAD, Operational amplifiers and Linear IC technology, PHI, 1987
3. Electronic Devices and Circuit Theorey, 9/e, ROBERT L. BOYLESTED, Pearson.

CS236	Data Structures Lab	ESC	3– 0–3	2 Credits

Pre-requisites: **CS235**

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop ADT for stack and queue applications
CO2	Implement tree and graph algorithms
CO3	Implement and analyze internal and external sorting algorithms
CO4	Design and implement symbol table using hashing technique

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3	3		
CO2							3	3		
CO3							3	3		
CO4							3	3		

Detailed syllabus

1. Write a program to implement stack using arrays.
2. Write a program to evaluate a given postfix expression using stacks.
3. Write a program to convert a given infix expression to postfix form using stacks.
4. Write a program to implement circular queue using arrays.
5. Write a program to implement double ended queue (de queue) using arrays.
6. Write a program to implement a stack using two queues such that the push operation runs in constant time and the pop operation runs in linear time.
7. Write a program to implement a stack using two queues such that the push operation runs in linear time and the pop operation runs in constant time.
8. Write a program to implement a queue using two stacks such that the enqueue operation runs in constant time and dequeue operation runs in linear time.
9. Write a program to implement a queue using two stacks such that the enqueue operation runs in linear time and dequeue operation runs in constant time.
10. Write programs to implement the following data structures: Single linked list, Double linked list
11. Write a program to implement a stack using a linked list such that the push and pop operations of stack still take O(1) time.
12. Write a program to implement a queue using a linked list such that the enqueue and dequeue operations of queue take O(1) time.
13. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it: Minimum key, Maximum key, Search

for a given key, Find predecessor of a node, Find successor of a node, delete a node with given key

14. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.
15. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.
16. Implement the following sorting algorithms: Insertion sort, Merge sort, Quick sort. Heap sort
17. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS
18. Write programs to find out a minimum spanning tree of a simple connected undirected graph by applying: (a) Prim's algorithm (b) Kruskal's algorithm
19. Write a program to implement Dijkstra's algorithm for solving single source shortest path problem using priority queue.
20. Write a program to implement Floydd-Warshall algorithm for solving all pairs shortest path problem.

MA251	Mathematics-IV	BSC	3–1–0	4 Credits

Pre-requisites: MA201

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand probability and statistics
CO2	Construct ordinary differential equations from the given data
CO3	Solve difference equations numerically and analytically.
CO4	Analyze any experimental data, using numerical methods and series solutions

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-

Detailed syllabus

Statistics and Probability:
Probability laws: Addition and Multiplication theorems on probability, Baye’s theorem
Random Variables: Discrete and continuous distributions, Expectations, Moments and Moment generating function, Binomial, Poisson and Normal distributions and fitting these distributions to the given data, Testing of Hypothesis; Z-test (for single mean and difference of means, single proportion and difference of proportions), t-test (for single mean and difference of means), F-test (for comparison of variances), Chi-square test for goodness of fit Correlation and Regression.

Numerical Analysis:
Numerical solution of algebraic and transcendental equations: Regula-Falsi method and Newton-Raphson method, Solution of linear system of equations: Gauss-Seidel iteration method and convergence (without proof). Calculation of dominant eigenvalue by iteration method, Curve fitting by the method of least squares: Fitting of (i) Straight lines (ii) Second degree parabola (iii) Exponential curves; Lagrange interpolation, Newton’s divided difference interpolation, Forward, backward and central differences. Newton’s forward and backward interpolation formulae; Gauss’s forward and backward interpolation formulae; Numerical differentiation at the tabulated points [with forward, backward and central differences]; Numerical Integration: Trapezoidal rule, Simpson’s 1/3 rule, Simpson’s 3/8 rule and Romberg integration.

Numerical solutions of ODE: Taylor series method, Euler's method, modified Euler's method, Runge-Kutta method of 2nd & 4th orders.

Series Solution:

Classification of singularities of an ordinary differential equation Series solution, Method of Frobenius -indicial equation –examples; Bessel function of first kind: Recurrence formulae, Generating function, Orthogonality of Bessel functions; Legendre polynomial: Rodrigue's formula, Generating function, Recurrence formulae, Orthogonality of Legendre polynomials.

Reading:

1. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, S.Chand & Co, 2006.
2. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications, 2008.
3. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

EC285	Digital Electronics	PCC	3–1– 0	4 Credits

Pre-requisites: EC101

Course Outcomes: At the end of the course the student will be able to:

CO1	Design combinational and sequential digital circuits to meet a given specification and be able to represent logic functions in multiple forms—understanding the advantages and disadvantages of each.
CO2	Understand how CMOS transistors can be used to realize digital logic circuits and understand basic characteristics of logic gates (such as power, noise margins, timing, tri-state circuitry, etc.).
CO3	Understand numerical and character representations in digital logic including ASCII, sign magnitude, 2's complement, and floating point and the corresponding design of arithmetic circuitry.
CO4	Understand the importance and need for verification and testing of digital logic circuits.
CO5	Understand the principle of operation and design of a wide range of electronic circuits such as computer RAM and ROM.
CO6	Understand how convert signals from analog to digital and digital to analog.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	-	1	-	-	-	-	-
CO2	2	2	-	1	-	-	-	-	-	-
CO3	2	2	-	1	1	-	-	-	-	-
CO4	2	2	3	1	-	-	-	-	-	-
CO5	2	2	-	1	1	-	-	-	-	-
CO6	2	2	3	1	-	-	-	-	-	-

Detailed syllabus

Number system and codes: Analog versus digital, merits of digital system, number systems, base conversions, complements of numbers, weighted and unweighted codes, and error detecting and correcting codes.

Switching algebra and switching functions: Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, minimization of Boolean functions using Karnaugh map and Quine McCluskey methods.

Logic Families: Characteristic parameters, Transistor-Transistor logic, TTL subfamilies, CMOS logic family, Implementation of Boolean function using CMOS logic, various logic gate ICs.

Combinational Logic: Principles and practices, Logic design of combinational circuits code conversion, parity generation and checking, multiplexers, de-multiplexers, encoders, decoders, buffers, tri-state buffers, IC Versions of Combinational logic circuits.
Sequential Logic: Review of Flip-Flops, Finite State model of sequential Circuits, modulus counter, shift registers, IC Version of sequential logic circuits.
Semiconductor Memories: RAM, ROM (Cell Structures and Organization on Chip)
Data Conversion Circuits: D/A converter specifications, A/D converter specifications, D/A converters such as DAC 0808, DAC 1408/1508, Integrated circuit A/D Converters ADC 0808, ICL 7106/7107.

Reading:

1. Linear Integrated Circuits, S Salivahanan, TATA MC Graw Hill.
2. Jain R.P, “Modern Digital Electronics”, Third edition, Tata Mc Graw Hill,2003
3. Floyd T.L., “Digital Fundamentals ", Prentice Hall, 9th edition, 2006
4. Anil K. Mani: Digital Electronics-Principles and Integrated Circuits, Wiley-India, 2007.
5. Herbert Taub, Schilling: Digital Integrated Electronics, TATA MC Graw Hill, 2008.

EE251	Circuit Theory-II	PCC	3–1–4	4 Credits

Pre-requisites: EE202

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze electric circuits using Network Theorems.
CO2	Evaluate Network Transfer function for any Electrical Network
CO3	Analyze given waveform through Fourier series and Fourier Transformation.
CO4	Design filters, attenuators and single port networks.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	-	-	-	-	3	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	3	-	-	-
CO4	3	3	-	3	3	-	-	-	-	-

Detailed syllabus

Network Theorems
Super position theorem, Reciprocity theorem, Thevenin's theorem, Norton's Theorem, Maximum power transform theorem, Millman's Theorem, and Tellegens's theorem.

Network Functions and Two Port Networks
Driving point impedance and transfer functions of 1-port RLC – networks, Impedance, admittance, Transmission and hybrid parameters of two-port networks and their interrelationship,
Natural frequencies of a network, poles and zeros, Restrictions on poles and zeros of driving point impedances.

Fourier Transforms and Fourier Series
Review of Fourier series and evaluation of Fourier coefficients, Trigonometric and complex Fourier series for repetitive waveforms, Amplitude and phase spectrums –Fourier transforms, and application to network analysis with non-sinusoidal repetitive waveform excitations.

Synthesis of Single –Port Networks
Positive real functions Hurwitz polynomials, Realization of passive LC –RL and RC networks using Foster and Caner forms.

Passive Filters and Attenuators

Classification and General Relations in filters, Constant K low pass, high pass and band pass filters; M derived low pass, high pass and band pass filters, Attenuators –symmetrical and asymmetrical.

Reading:

1. M.F. Van Valkan Burg : Network Analysis –3/e edition, PHI Publications, 2002
2. GOPAL –G. Bhise & Prem Chadha: Engineering Network Analysis and Filter Design, Umesh Publications, 2000.
3. N.C. Jagan, C. Lakshminarayana: Network Theory, BS publications, 2003.

EE252	Electrical Machines-I	PCC	3–1–0	4 Credits

Pre-requisites: EE101

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO2	Analyze the effect of armature reaction and the process of commutation.
CO3	Analyze parallel operation of DC Generators, single phase and three phase transformers
CO4	Evaluate performance of DC machines and transformers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2		3	1						3
CO2	2	2	2	1						
CO3	3	3	3	1						
CO4	2	2	2							

Detailed syllabus

DC Machines:
Constructional details, Simplex and multiplex lap and wave windings; Methods of excitation, characteristics of saturated and un-saturated series, shunt, cumulatively and differentially compound excited machines operating as motors and generators; Armature reaction, demagnetizing and cross magnetizing ampere turns, compensating windings, commutation, interpoles.
Speed control methods of D.C. shunt & series motors, losses and efficiency; 3 point starter, 4-point Starter for D.C. motors and design of 3-point starter.
Testing of D.C. machines: No-load test, Direct load test, Hopkinson's and Field's test, Retardation test. Principle of operation and applications of Amplidyne and Metaldyne generators.

Single Phase Transformers:
Construction, principle of operation, EMF equation, phasor diagram; Equivalent circuit, determination of equivalent circuit parameters, Losses, calculation of efficiency and regulation by direct and indirect methods; Predetermination of performance by Sumpner's test, Load sharing and operation of transformers in parallel, Separation of no load losses by experimental method, principle of auto transformer, Saving of copper compared to two winding transformer

and its application; Cooling methods of transformers.

Three Phase Transformer:
Type of connections, Relation between line and phase voltages and currents, use of tertiary winding, Scott connection of transformers for phase conversion:

Tap Changing Transformers:
Concept of tap changing, on-load and off-load tap changers, single phase and three phase induction regulators and moving coil regulators.

Reading:

1. P. S Bimbhra-Electrical Machines-Khanna Publishers, 2002
2. A.E Fitzgerald, Charles Kingsley, Stephen D Umans Electrical Machines –TMH Publishers, 6th Edn, 2003.
3. Nagarath & D.P.Khothari : Electrical Machines, TMH Publishers, 4th Edn, 2004
4. J.B. Gupta: Theory &Performance of Electrical Machines SK Kataria & Sons, 4th Edn. 2006.
5. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines.

EE253	Power Systems-I	PCC	4– 0–0	4 Credits

Pre-requisites: EE101

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the operation of conventional generating stations and renewable sources of electrical power.
CO2	Evaluate the power tariff methods.
CO3	Determine the electrical circuit parameters of transmission lines
CO4	Understand the layout of substation and underground cables and corona.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	3	-	-	-	-	3	3	3
CO2	2	2	-	-	-	3	-	3	3	3
CO3	3	3	-	2	3	-	-	-	3	-
CO4	1	-	3	-	-	-	-	-	3	-

Detailed syllabus

Introduction: Typical Layout of an Electrical Power System–Present Power Scenario in India.

Generation of Electric Power:
Conventional Sources (Qualitative):
Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant.
Non Conventional Sources (Qualitative):
Ocean Energy, Tidal Energy, Wave Energy, wind Energy, Fuel Cells, and Solar Energy, Cogeneration and energy conservation and storage.

Economics of Generation:
Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

A.C. Distribution:
Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation.

Overhead Line Insulators:

Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators.

Insulated Cables:
Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables.

Inductance and Capacitance Calculations of Transmission Lines:
Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance.

Corona:
Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines.

Reading:

1. W.D.Stevenson –Elements of Power System Analysis, Fourth Edition, McGraw Hill, 1984.
2. C.L. Wadhwa –Generation, Distribution and Utilization of Electrical Energy, Second Edition, New Age International, 2009
3. C.L. Wadhwa –Electrical Power Systems, Fifth Edition, New Age International, 2009
4. M.V. Deshpande –Elements of Electrical Power Station Design, Third Edition, Wheeler Pub. 1998
5. H.Cotton & H. Barber-The Transmission and Distribution of Electrical Energy, Third Edition, ELBS, B.I.Pub., 1985

EC286	Integrated Circuit Applications Lab	PCC	0– 0– 3	2 Credits

Pre-requisites: EC235, EC285

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze and design applications using OPAMP IC 741.
CO2	Design and construct waveform generation circuits
CO3	Verify the functionality of combinational and sequential circuit ICs.
CO4	Design combinational and sequential circuits using Digital ICs

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	2	-	3	-	-	-
CO2	3	3	3	2	2	-	3	-	-	-
CO3	-	-	3	2	3	-	3	-	-	-
CO4	3	3	3	2	2	-	3	-	-	-

Detailed syllabus

List of Experiments:

1. Study and Operation of IC testers, pulse generator and digital trainer.
2. Measurement of Op.amp parameters:
3. Offset voltage
4. Offset current
5. CMRR
6. Slew rate
7. Open loop gain
8. Input impedance.
9. Op.amp monostable and astable multivibrators.
10. 555 timer: Monostable and astable multivibrators.
11. Characteristics of TTL NAND gate: (i) Sourcing (ii) Sinking (iii) Transfer
12. Study of flip-flops: RS, JK, T and D.
13. Mod-N counter using 7490 and 74190.
14. Mod-N counter using 7492 and 74192.
15. MUX and decoder ICSs (IC 74153&74138).
16. Shift register IC 7495.

Reading:

1. J.MILLMAN, Microelectronics, Mc grawhill, 1987.
2. RAMAKANT A. GAYAKWAD, Operational amplifiers and Linear IC technology, PHI, 1987

EE254	Electrical Measurements Lab	PCC	0– 0–3	2 Credits

Pre-requisites:EE 201

Course Outcomes: At the end of the course the student will be able to:

CO1	Calibrate single phase energy meters
CO2	Measure Resistance, Inductance and capacitance using AC and DC bridges
CO3	Determine the magnetization characteristics and hysteresis loss
CO4	Determine ratio error and phase errors in CTs and PTs
CO5	Determine the characteristics of RTD, thermistor, pressure & weight transducers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	2	3	-	-	3	-	3	-
CO2	3	-	2	3	-	-	3	-	-	-
CO3	3	-	3	3	-	-	3	-	-	-
CO4	-	-	3	3	-	-	3	-	-	-
CO5	3	3	3	-	-	-	2	-	-	-

Detailed syllabus

List of Experiments:

1. Hysteresis loop using CRO
2. Single phase Energy Meter
3. Kelvin's Double Bridge
4. Maxwell's bridges
5. Potential transformer
6. A.C Bridges
7. Transducer (Temperature measurements
8. Transducer

Reading

1. K. Sawhney-A course in Electrical Measurements Electronic Measurements and Instrumentation-Dhanpat Rai and Sons.
2. W.D. Coopers and Helfrick-Modern Electronic instrumentation and Measurements Techniques, Printice Hall of India P. Ltd.2002.
3. E.W. Gowlding and F.C.Widdis: Electrical Measurements and Measuring Instruments 5/e, Wheeler pub.1998

EE301	Control Systems	PCC	3–1–0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyse electromechanical systems by mathematical modelling.
CO2	Determine Transient and Steady State behavior of systems using standard test signals.
CO3	Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability
CO4	Identify and design a control system satisfying requirements..

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	-	3	-	3	-	-	-
CO2	2	3		3	3	-	3	-	-	-
CO3	2	-	3	-	3	-	-	-	-	-
CO4	2	3		3	3	-	-	-	-	-

Detailed syllabus

Introduction: System, control system, types of control systems, open-loop and closed loop systems, types of feedback, feedback and its effects. Concept of linearization with incremental changes.

Mathematical Modelling of Physical Systems: Mathematical modelling of Electrical, Mechanical and Electro-mechanical elements, Synchros D.C. motors, two-phase a.c motors. Block diagram representation of them. Concept and use of Transfer function.

Transfer Function from Block Diagrams and Signal Flow Graphs: Introduction, impulse response and its relation with transfer function of linear systems. Block diagram reduction technique and signal flow graph, Mason's gain formula.

State Variable Analysis of Linear Dynamic Systems: State variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Time Domain Analysis of Control Systems: Introduction- typical Test signals, time domain indices, steady state error constants, error series, concept of BIBO stability, absolute stability, Routh-Hurwitz Criterion. Effect of P, PI & PID controllers.

Root Locus Techniques: Introduction, Root loci theory, Application to system stability studies. Illustration of the effect of addition of a zero and a pole.

Frequency Domain Analysis of Control Systems: Introduction, polar plots, Nyquist stability criterion, Frequency domain indices (gain margin, phase margin, bandwidth), Bode plots, application of Bode plots, M&N circles, Nichols charts, Application of Nichols charts.

Design Of Compensators: Need of compensators, design of lag and lead compensators using Bode plots.

Reading:

1. B.C. Kuo: Automatic Control Systems – Prentice Hall of India, 7th Edition, 2004

2. I.J. Nagarath, M.Gopal: Control Systems Engineering (2nd-Edition) —New Age Pub. Co.

EE302	Electrical Machines-II	PCC	3–1–0	4 Credits

Pre-requisites: EE252

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the construction and principle of operation of induction machines and synchronous machines.
CO2	Evaluate performance characteristics of induction machine and synchronous machines
CO3	Analyze speed torque characteristics and control the speed of induction motors
CO4	Analyse the effects of excitation and mechanical input on the operation of synchronous machine

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3	3							3
CO2		3	3	1						
CO3	1	3	2		1					
CO4	1	3	3	1						

Detailed syllabus

3-Phase Induction Motor:

Constructional details, types, production of magnetic field-principle of operation, Phasor diagram, equivalent circuit. Torque equation-starting and maximum torque-maximum output, slip for max. Output, Torque-slip characteristics, losses and efficiency. Testing-no load and blocked rotor tests-determination of equivalent circuit parameters ,Pre-determination of performance from equivalent circuits and circle diagram, Methods of starting-auto transformer, star delta and rotor resistance starters, Double cage induction motor –construction, theory, equivalent circuit, Characteristics and applications. Induction generator-principle of operation, equt. Circuit and application.

Synchronous Generator:

Construction, types, winding factors, production of emf, harmonics, armature reaction, Synchronous reactance, phasor diagram, load characteristics, open circuit and short circuit tests.

Methods of pre-determination of regulation by synchronous impedance, ampere turn, Potier triangle and ASA methods. Two reaction theory –analysis and its application for the pre-determination of regulation of salient pole alternator, phasor diagram. Slip test, power angle characteristics, synchronization and synchronizing power. Parallel operation and load sharing–operation on infinite bus-bar typical applications.

Synchronous Motor:

Theory of operation–phasor diagrams, variation of current and power factor with excitation.

Hunting and its suppression, determination and pre-determination of V and inverted V curves.

Excitation circles, power circles, method of starting.

Reading:

1. P.S. Bimbhra: Electrical Machinery –Khanna Publishers.
2. Charbs.I. Hubert: Electric Machines –Second Edition –Pearson 2003.
3. Stephen.J.Chapman: Electric Machinery –Mc Graw Hill International Edition, 2005.
4. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery –Sixth Edition TMH 2003.

EE303	Power Systems-II	PCC	3–1–0	4 Credits

Pre-requisites: EE253

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze transmission line performance.
CO2	Apply load compensation techniques to control reactive power
CO3	Understand the application of per unit quantities.
CO4	Design over voltage protection and insulation coordination
CO5	Determine the fault currents for symmetrical and unbalanced faults

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	-	1	-	-	-	-	3	-
CO2	2	1	-	3	-	-	-	-	2	-
CO3	1	1	-		-	-	-	-	3	3
CO4	1	2	-	3	2	-	-	-	2	-
CO5	1	1	--	1	-	-	-	--	2	-

Detailed syllabus

Performance of Lines

Representation of lines, short transmission lines, medium length lines, nominal T and PI-representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram.

Voltage Control

Introduction – methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers.

Compensation in Power Systems

Introduction - Concepts of Load compensation – Loadability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

Per Unit Representation of Power Systems

The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system.

Travelling Waves on Transmission Lines

Production of traveling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

Overvoltage Protection and Insulation Coordination

Over voltage due to arcing ground and Peterson coil, lightning, horngaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves.

Symmetrical Components and Fault Calculations

Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus.

Reading:

1. John J. Grainger & W.D. Stevenson : Power System Analysis – Mc Graw Hill International 1994.
2. C.L. Wadhwa: Electrical Power Systems – New Age International Pub. Co.Third Edition, 2001.
3. Hadi Scadat: Power System Analysis – Tata Mc Graw Hill Pub. Co. 2002
4. W.D. Stevenson : Elements of Power system Analysis – McGraw Hill International Student Edition.
5. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis - Tata Mc Graw Hill Pub. Co., New Delhi, Fourth edition, 2011

EE304	Electrical Machines Lab-I	PCC	0– 0–4	3 Credits

Pre-requisites:EE 252

Course Outcomes: At the end of the course the student will be able to:

CO1	Select range of apparatus based on the ratings of DC Machines and Transformers.
CO2	Determine equivalent circuit parameters of transformers
CO3	Evaluate the efficiency of the machine by analyzing test results
CO4	Study speed control methods for dc machines

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	2	3	-	-	3	-	-	-
CO2	1	3	2	1	-	-	3	-	-	-
CO3	1	3	3	3	-	-	3	-	-	-
CO4	1	3	3	2	3	-	3	-	-	-

Detailed syllabus

1. Determination of open circuit characteristic of D.C. machine
2. Determination of Load characteristics of D.C. generators
3. Speed control of D.C. motors using Armature control and Field control methods
4. Brake test on D.C. Shunt motor
5. Fields test on two identical D.C. Series machines
6. Retardation test on D.C. machines to determine moment of Inertia
7. Hopkinson test on two identical D.C. machines
8. O.C. and S.C. tests on single phase transformer
9. Load test on single phase transformer
10. Sumpners test on two single phase transformers
11. Scott connection of single phase transformers
12. Separation of no load losses of a single phase transformer

EE305	Circuits Lab	PCC	0– 0–3	2 Credits

Pre-requisites: EE202, EE251

Course Outcomes: At the end of the course the student will be able to:

CO1	Validate network theorems
CO2	Determine Z, Y and ABCD parameters for a given two port network.
CO3	Evaluate the time response and frequency response characteristics of RLC series circuit and their resonance conditions.
CO4	Simulate electrical circuits using PSpice

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	3	-	-	-	-	-	-
CO2	1	1	3	3	-	-	3	-	-	-
CO3	1	1	3	3	-	-	3	-	-	-
CO4	-	1	2	3	-	-	3	-	-	-

Detailed syllabus

1. Frequency response of second order RLC series circuit
2. Time response of second order RLC series circuit
3. Open circuit, Short circuit and ABCD parameters of two port networks
4. Verification of Kirchhoff's laws and Tellegen's Theorem
5. Verification of superposition and Thevenin's Theorem
6. Verification of Maximum power transfer and Reciprocity Theorems
7. Phase lead network and Polar plots of Phasors I, V_R, VC and V_{RC}
8. Measurement of active and reactive powers of a 3-phase network using two wattmeters.
9. Simulation of Frequency response of second order RLC series circuit using PSPICE
10. Simulation of Time response of second order RLC series circuit using PSPICE
11. Verification of superposition and Thevenin's Theorem using PSPICE

EE306	Electrical Simulations Laboratory	PCC	0– 0–3	2 Credits

Pre-requisites: EE202, EE252, EE301, EE303

Course Outcomes: At the end of the course the student will be able to:

CO1	Simulate and analyse electrical and electronic circuits.
CO2	Analyze and solve power flow problem in power systems
CO3	Model, simulate and analyze the performance of DC Machines
CO4	Analyze performance of feedback and load frequency control systems
CO5	Evaluate the performance of transmission lines

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	-	-	3	-	-	-
CO2	3	1	2	3	-	-	3	-	-	-
CO3	1	2	2	3	-	-	3	-	-	-
CO4	2	2	2	3	-	1	2	-	-	-
CO5	2	1	2	3	-	-	2	-	-	-

Detailed syllabus

Experiments:

1. Design and simulate the characteristics of first and second order circuits in time and frequency domain using Pspice
2. Simulation of three phase bridge rectifier using Pspice
3. Performance evaluation of medium and long transmission lines using Matlab
4. Symmetrical component analysis using Matlab
5. DC Motor Speed control using Matlab/Simulink
6. Design and analyse the performance of feedback control system
7. Simulate and tune parameters of a PID controller for a given system
8. Load frequency control of single area and two area power system with Matlab / Simulink
9. Performance of FC-TCR compensator using PSCAD/ EMTDC
10. Permanent Magnet DC motor simulation using Matlab/Simulink

Reading:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.
3. Control Systems Engineering-I.J. Nagrath & M.Gopal- New Age International Pub. Co
4. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines.

EE311	Computer Organization	DEC	3– 0–0	3 Credits

Pre-requisites: EC 285

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the characteristics of functional components of a computer system
CO2	Determine the architectural features and functional inter-relationships between CPU, Memory, IO and operating system
CO3	Analyse the hierarchical structure of computer system components and determine how they influence performance.
CO4	Design a memory organization for a choice of memory chips
CO5	Analyse the internal architecture of ALU and control unit to improve performance
CO6	Identify the characteristics of IO device and design a IO configuration for CPU intensive and IO intensive applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3	2					
CO2				3						
CO3	1			3	3					
CO4				3						
CO5				3						
CO6				3						1

Detailed syllabus

Introduction: Historical review, evolution and design considerations, Computer evolution and performance organization and architecture, structure and function, Computer interconnection structures.

Interconnection structures: Bus Interconnection structures, Elements of bus design, Example bus systems, Signals, operations, commands and timing diagrams, Futurebus and other bus standards

Internal Memory: Characteristics of hierarchical memory systems, components and types Memory organization, Cache memory organization and elements of cache design, Mapping functions, replacement algorithms and hardware

Operating system support: OS as a resource manager, Role of memory management and techniques, Virtual memory, address translation and implementation

External memory: Types of external memory devices and characteristics
Input/output subsystem: Characteristics of I/O data transfer, External interfaces
Front system bus (FSB) and its implication in I/O data transfer
CPU – Arithmetic unit: Number systems and representations, Functions of ALU, Floating point number operations.
CPU – Processing Unit: Machine instruction formats, Instruction execution, CISC Vs RISC processors, superscalar processors.
CPU – Control Unit: Internal organization of CPU – micro-operations, Micro-programmed control unit, Advantages and disadvantages of Micro-programmed control unit, Hardwired control unit.
Recent trends in computer systems: Parallel processing, Vector processing, optimization of main memory across processors

Reading:

1. Computer Organization and Design-The HW/SW Interface: Peterson and Hennessey, Elsevier Pub.
2. Computer organization and Architecture-Designing for performance: William Stallings, PHI
3. Computer Organization: Hamacher, Vranesic and Zaky, McGraw Hill, ISE
4. Computer Organization: John P Hayes, McGraw Hill, ISE

EE312	Design of Electrical Systems	DEC	3– 0–0	3 Credits

Pre-requisites: **EE302**

Course Outcomes: At the end of the course the student will be able to:

CO1	Formulate equations for electric and magnetic circuits of electric machines.
CO2	Draw flow charts and write computer programs to solve the above equations
CO3	Understand optimum design procedure for electrical machines.
CO4	Select suitable layout and components for a sub-station

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3							
CO2	3	3	3							
CO3	3	3	3							
CO4	3	3	3							

Detailed syllabus

Design of Electrical and Magnetic Circuits of Electrical Machines:
Formation of mathematical equations for electric and magnetic circuits, Flow charts and computer formation of design of electric and magnetic circuits for DC machines, Power transformers, Induction motors and Synchronous motor.

Design of Thermal Circuit Of Electrical Machines
Formation of mathematical equations for thermal circuits, Flow charts and computer formation of design of thermal circuits for DC machines, Power transformers, Induction motors and Synchronous motor.

Design of Rotating Electrical Machines
Optimum Design procedures for Electrical M AC & DC machines-Criteria for optimization –flow Charts and Computer Programs.

Design of Sub-Station
Indoor and outdoor substations, selection of site and layout, single feeder and double feeder substations, design of power capacitors, selection of circuit breakers and isolators.

Reading:

1. *M.Ramamurthy, Computer aided Design of Electrical Equipment, East West Press Pvt. Ltd. Madras, 1988.*
2. *C.G. Veinott, Computer aided design of FHP motors, McGraw Hill Pub. Co.*
3. *M.G.Say, Performance and Design of AC Machines, Pitman Pub.*
4. *E Clayton & N.N. Hancock, Performance and Design of DC machines CBS Pub. 3rd Edn. 1998.*
5. *H.Partab, Arts and Science of Utilization of Electrical Energy.*

EE313	Digital Signal Processing	DEC	3– 0–0	3 Credits

Pre-requisites: MA251

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the dynamics of a Linear, Time Invariant and Causal digital systems using convolution
CO2	Understand the sampling theorem and relationship between the time domain and frequency domain description of signals and systems
CO3	Determine the behavior of digital systems using Discrete Time Fourier Transformation and the Z-transformation
CO4	Synthesize IIR & FIR filters using direct, transposed, cascade, parallel and state-space structures

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3						

Detailed syllabus

Signals and Systems:
Sampling, Discrete-time signals, aliasing, impulse response, LTI systems, convolution, difference equations.
Fourier analysis and Z-Transform:
DTFT, properties, applications, Definition of z-transform, properties, inverse z-transform, one-sided z-transform
Transform Analysis of Systems:
System function, systems with linear phase, all pass filters, minimum phase systems.
Discrete Fourier and Fast Fourier Transforms: DFT, DFT properties, sampling the DTFT, Linear convolution using DFT, Radix-2 FFT algorithms, decimation in time, decimation in frequency.
Implementation of Discrete Time Systems:
Direct, cascade and parallel structures for FIR systems & IIR systems

Reading:

1. Salivahanan, Vallavaraj, Gnanapriya-Digital signal processing –TMGH –2002
2. Proakis and Manolakis-Digital signal processing principles –algorithms and applications-PHI –2003
3. Oppenheim and Schaefer –Discrete time signal processing –PHI –1999

EE314	Electrical Engineering Materials	DEC	3– 0–0	3 Credits

Pre-requisites:EE101

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate insulating, conducting and magnetic materials used in electrical machines.
CO2	*Understand the properties of liquid, gaseous and solid insulating materials*.
CO3	Evaluate transformer oil by testing

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1							
CO2	1	1	1							
CO3	1	1	1							

Detailed syllabus

DIELECTRIC MATERIALS

Dielectric as Electric Field Medium,leakage currents, dielectric loss,dielectric strength, breakdown voltage,breakdown in solid dielectrics, flashover,liquid dielectrics,electric conductivity in solid,liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields,spontaneous,polarization, curie point, anti-ferromagnetic materials,piezoelectric materials,pyroelectric materials.

MAGNETIC MATERIALS

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials,magnetic Anisotropy,Magnetostriction,diamagnetism, magnetically soft and hard materials,special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets,ageing of magnets.factors effecting permiablity and hystersis.

SEMICONDUCTOR MATERIALS

Propertiesof semiconductors, Silicon wafers, integration techniques,Large and very large scale integration techniques (VLSI).

MATERIALS FOR ELECTRICAL APPLICATIONS

Materials used for Resistors, rheostats, heaters, transmission linestructures, stranded conductors, bimetals fuses, soft and hard solders,electric contact materials, electric carbon materials, thermocouple materials.Solid Liquid and Gaseous insulating materials. Effect of moisture on insulation.

SPECIAL PURPOSE MATERIALS
Refractory Materials, Structural Materilas, Radiaoactive Materials,Galvonization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI

Reading:

1. R K Rajput: A course in Electrical Engineering Materials, Laxmi Publications. 2009
2. T K BasaK: A course in Electrical Engineering Materials:, New Age Science Publications 2009
3. TTTI Madras: Electrical Engineering Materials
4. Adrianus J.Dekker: Electrical Engineering Materials , THM Publication.

EE315	Microprocessors and Applications	DEC	3– 0–0	3 Credits

Pre-requisites: EC 285

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic architecture of 8086 microprocessor.
CO2	Write assembly language programs to perform a given task.
CO3	Write interrupt service routines for all interrupt types
CO4	Interface memory and I/O devices to 8086 using peripheral devices
CO5	Write microcontroller programs and interface devices

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3						
CO5				3	3					

Detailed syllabus

Introduction:Evolution of Microprocessors, Internal Architecture of 8086, BIU and EU, Registers in of 8086, Memory segmentation

Instruction sets and Addressing modes: Addressing modes-register related, Addressing modes-memory related, Instruction formats, Instruction set of 8086-functional groups, Assembler Directives, assembly language programming.

Pin and timing diagrams of 8086: Pin diagram of 8086 in minimum mode & Maximum mode configuration, Timing diagram of typical read write instructions.

Interrupts- Steps in interrupt process, Interrupt structure in 8086, Internal and external interrupts-interrupt service routines.

Interfacing the microprocessor- Interfacing of I/O devices, Interfacing I/O-programmable peripheral interface-8255, Interfacing of multi digit seven segment display, Interfacing timer-Programmable interval timer-8254.

Serial interface and data converters-USART 8251, Serial interface standards-RS 232 C and RS -485, Interfacing of ADCs and DACs,

Microcontrollers- Introduction to Microcontroller, 8051 Microcontroller, memory and I/ O organization, Applications of Microcontroller.

Reading:

1. Douglas V. Hall : Microprocessors and Interfacing, TMH-Revised Second Edition, 2005
2. A.K. Ray & Burchandi: Advanced Microprocessors and Peripherals, TMH, 2003.
3. Ajay V. Deshmukh: Microcontrollers –Theory and Applications, TMH, 2009.

EE316	Utilization of Electrical Energy	DEC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand basic principles of electric heating and welding.
CO2	Determine the lighting requirements for flood lighting, household and industrial needs.
CO3	Calculate heat developed in induction furnace.
CO4	Evaluate speed time curves for traction

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2							
CO2		3								
CO3	1	1	1							
CO4	1	1	1							

Detailed syllabus

Electrical Heating and Welding

Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating. Electric welding: Electric welding equipment, resistance welding and arc welding, comparison between AC and DC welding. Electrolysis process:principle of electrolysis, electroplating, metal extraction and metal processing, electromagnetic stirs.

Illumination

Terminology, Laws of illumination, coefficient of Utilisation and depreciation, Polar curves, photometry, integrating sphere, sources of light, fluorescent lamps, compact fluorescent lamps, LED lamps discharge lamps, mercury vapour lamps, sodium vapour lamps and neon lamps,comparison between tungsten filament lamps and fluorescent tubes. Basic principles of light control, Types and design of lighting scheme, lighting calculations, factory lighting, street lighting and flood lighting.

Electric Traction

Systems of electric traction and track electrification- DC system, single phase and 3-phase low frequency and high frequency system, composite system, kando system, comparison between AC and DC systems, problems of single phase traction with current unbalance and voltage unbalance. Mechanics of traction movement, speed – time curves for different services, trapezoidal and quadrilateral speed – time curves, tractive effort, power, specific energy consumption, effect of varying acceleration and braking, retardation, adhesive weight and braking retardation, coefficient of adhesion.Systems of train lighting, special requirements of train lighting, methods of obtaining unidirectional polarity constant output- single battery system, Double battery parallel block system, coach wiring, lighting by making use of 25KV AC supply.

Reading:

1. H. Partab: Modern Electric Traction, Dhanpat Rai & Co, 2007.
2. E. Openshaw Taylor: Utilisation of Electric Energy, Orient Longman, 2010.
3. H. Partab: Art & Science of Utilisation of Electric Energy, Dhanpat Rai & Sons, 1998.
4. N.V. Suryanarayana: Utilisation of Electrical power including Electric drives and Electric Traction, New Age Publishers, 1997.

SM335	ENGINEERING ECONOMICS AND ACCOUNTANCY	HSC	3 – 0 – 0	3 Credits

Prerequisites: None.

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

CO1	Prepare accounting records and summarize and interpret the accounting data for managerial decisions
CO2	Understand the macro-economic environment of the business and its impact on enterprise
CO3	Understand cost elements of the product and its effect on decision making
CO4	Understand the concepts of financial management and smart investment

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3				
CO2						3				
CO3						3				
CO4						3				

Detailed Syllabus:

Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals – Methods of Economic analysis. The effect of borrowing on investment-Various concepts of National Income – Significance of National Income estimation and its limitations, Inflation –Definition – Process and Theories of Inflation and measures to control, New Economic Policy 1991 – Impact on industry.

Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet.

Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations.

Reading:

1. Henry Malcom Stenar, Engineering Economic Principles, McGraw Hill, 2005.
2. K K Dewett, Modern Economic Theory, Siltan Chand & Co., 2005.

3. Agrawal AN, Indian Economy, Wiley Eastern Ltd, New Delhi, 2012.
4. Jain and Narang, Accounting Part-I, Kalyani Publishers, 2012.
5. Arora, M.N., Cost Accounting, Vikas Publications, 2013.

EE351	Power Systems Operation and Control	PCC	3–1–0	4 Credits

Pre-requisites: **EE253, EE303**

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand operation and control of power systems.
CO2	Analyze various functions of Energy Management System (EMS) functions.
CO3	Analyze whether the machine is in stable or unstable position.
CO4	Understand power system deregulation and restructuring

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	-	3	-	1	-	1	3	3	3
CO2	3	1	1	-	-	-	-	3	3	3
CO3	1	1	1	-	-	-	-	-	-	-
CO4	3		2	1	-	-	-	3	3	2

Detailed syllabus

LOAD FLOW STUDIES:
Introduction, Bus classification -Nodal admittance matrix - Load flow equations - Iterative methods - Gauss and Gauss Seidel Methods, Newton-Raphson Method-Fast Decoupled method-Merits and demerits of the above methods-System data for load flow study.

P –Q CONTROL:
Effect of synchronous machine excitation-Power angle of a synchronous machine-Specification of bus voltagesCapacitor banks, control by transformers.

ECONOMIC OPERATION OF POWER SYSTEMS:
Distribution of load between units within a plant-Transmission loss as a function of plant generation, Calculation of loss coefficients-Distribution of load between plants.

LOAD FREQUENCY CONTROL:
Introduction, load frequency problem-Megawatt frequency (or P-f) control channel, MVAR-voltages (or Q-V) control channel-Dynamic interaction between P-f and Q-V loops. Mathematical model of speed-governing system-Turbine models, division of power system into control areas, P-f control of single control area (the uncontrolled and controlled cases)-P-f control of two area systems (the uncontrolled cases and controlled cases)

POWER SYSTEM STABILITY:

The stability problem-Steady state stability, transient stability and Dynamic stability-Swing equation. Equal area criterion of stability-Applications of Equal area criterion, Step by step solution of swing equation-Factors affecting transient stability, Methods to improve steady state and Transient stability, Introduction to voltage stability

POWER SYSTEM DEREGULATION (Qualitative treatment only)

Introduction - Power system restructuring models- responsibilities and functions of independent system operator (ISO) – Ancillary Services

Reading:

1. C.L.Wadhwa, Electrical Power Systems, 3rd Edn, New Age International Publishing Co., 2001.
2. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, 4th Edn, Tata McGraw Hill Education Private Limited 2011.

EE352	Power Electronics	PCC	3–1–0	4 Credits

Pre-requisites: EE101, EC101

Course Outcomes: At the end of the course the student will be able to:

CO1	Compare characteristics of switching devices.
CO2	Evaluate the performance of rectifiers.
CO3	Design DC-DC converter with given characteristics
CO4	Analyze and evaluate the operation of Inverters and Cycloconverters

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3	3	-	-	-	-	3
CO2	3	2	3	3	2	-	-	-	-	3
CO3	1	2	1	3	3	-	-	-	-	-
CO4	1	2	2	3		-	-	-	-	-

Detailed syllabus

INTRODUCTION:
Concept of power electronics, scope and applications, types of power converters, power semiconductor switches and their V-I characteristics-diodes, SCR,TRIAC, power BJT, power MOSFET, Thyristor ratings and protection, methods of SCR commutation, UJT as a trigger source, gate drive circuits for BJT and MOSFETs

PHASE CONTROLLED RECTIFIERS
Principles of single-phase fully-controlled converter with R, RL, and RLE load, Principles of single-phase half-controlled converter with RL and RLE load, Principles of three-phase fully-controlled converter operation with RLE load, Effect of load and source inductances, General idea of gating circuits, Single phase and Three phase dual converters

DC-DC CONVERTERS
Introduction, Basic principles of step-down and step-up operation,chopper classification study of Buck, Boost and Buck-Boost regulators, limitations of single-stage conversion, Introduction to forward and flyback converters.

INVERTERS
Introduction, principle of operation, performance parameters, single phase bridge inverters with R, RL and RLC loads, 3-phase bridge inverters - 120 and 180 degrees mode of operation,

Voltage control of single phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

A.C. VOLTAGE CONTROLLERS
Introduction, principle of operation of single phase voltage controllers for R, R-L & R-L-E loads and its applications.

CYCLOCONVERTERS
Principle of operation of single phase cycloconverters, relevant waveforms, circulating current mode of operation, Advantages and disadvantages.

Reading:

1. M.H.Rashid, Power Electronics - Circuits, Devices and Applications, PHI, 2002.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 2002.
3. Mohan Undeland Robin, Power Electronics - Converters, Applications and Design, John Wiley & Sons, 2002.

EE353	Power System Protection	PCC	3–1–0	4 Credits

Pre-requisites: EE 303

Course Outcomes: At the end of the course the student will be able to:

CO1	Compare and contrast electromagnetic, static and microprocessor based relays
CO2	Apply technology to protect power system components.
CO3	Select relay settings of overcurrent and distance relays.
CO4	Analyse quenching mechanisms used in air, oil and vacuum circuit breakers

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4	3	3								

Detailed syllabus

Protective Relays

Introduction, Need for power system protection, effects of faults, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology.

Operating Principles and Relay Construction

Electromagnetic relays, thermal relays, static relays, microprocessor based protective relays.

Overcurrent Protection

Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.

Distance Protection

Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, auto re-closing.

Pilot Relaying Schemes

Wire Pilot protection, Carrier current protection.

Ac Machines and Bus Zone Protection

Protection of Generators, Protection of transformers, Bus-zone protection, frame leakage protection.

Static Relays

Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, static over current relays, static directional relay, static differential relay, static distance relays, Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics.

Microprocessor Based Relays

Advantages, over current relays, directional relays, distance relays.

Circuit Breakers

Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuit breakers.

Fuses

Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination.

Reading:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH 2001.
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications, 2009.
3. C.Russel Mason – “The art and science of protective relaying, Wiley Eastern, 1995
4. L.P.Singh “Protective relaying from Electromechanical to Microprocessors”, New Age International

EE354	Electrical Machines-III	PCC	3–1– 0	4 Credits

Pre-requisites:EE 302

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the working of single phase induction motors
CO2	*Analyze and model single phase induction motor, reluctance motor, stepper motor, hysteresis motor and universal motors*
CO3	Analyze the operation and performance of PMDC and BLDC motors
CO4	Design of electrical circuit, magnetic circuits and main dimensions of transformers, three phase induction machine and synchronous machines

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	-	2	3	1	-	-	-	-	-	3
CO2	1	2	2	1	-	-	-	-	-	-
CO3	2	2	2		-	-	-	-	-	-
CO4	2	2		3	3	-	-	-	-	-

Detailed syllabus

Single Phase Induction Motors:
Principle of operation, Double revolving field theory, speed-torque characteristics, Equivalent circuit, Phasor diagrams, Determination of equivalent circuit parameters, Starting methods, Split phase starting, Resistance starting, Capacitance starting, Shade pole starting, Speed control methods, Applications, Principle of cross field theory, Problem on all the above motors.

Single Phase Synchronous Motors:
Construction, principle of operation and applications of Reluctance motors, Hysteresis motors, Sub-synchronous motors.

AC Series Motors:
Construction, Principle of operation, Phasor diagrams and Characteristics of Single phase and Three Phase AC Series motors, Simple and compensated motors, Universal motors and their Applications, Problems on all the above motors.

Schrage Motor:
Construction, Principle of operation, Speed and power factor control, Applications.

Special Purpose Machines: Construction and principle of operation of Stepper motors, Permanent magnet DC motors, Brushless DC motors, Linear Induction motors and their Applications, Problems on all the above motors.

Multi Winding Transformers: Construction, Equivalent circuits, Determination of equivalent circuit parameters, Voltage regulation, Efficiency calculations.

Energy Efficient Machines (Qualitative treatment only):
Construction, Basic Concepts, losses minimization and efficiency calculations of Energy efficient AC machines.

Super Conducting Machines (Qualitative treatment only):
Construction, Principle of operation and basic concepts of super conducting AC machines.

Reading:

1. A.E.Fitzgerald, Charles Kingsley and Stepen D.Umans: Electric Machinery, Tata McGraw-Hill Pub, Sixth Edition, 2002.
2. P.S.Bimbhra: Generalized Theory of Electrical Machines, Khanna Pub. 1997.
3. D.P. Kothari and I.J.Nagarath: Electric Machines: Tata McGraw-Hill Pub., Third Edn, 2004.
4. P.S. Kenjo and S.Nagamori: Permanent Magnet DC motors, Clarendon Press, Oxford, 1985.
5. J.B.Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, Fourteenth Edn, 2006.

EE355	Control Systems Laboratory	PCC	0– 0–3	2 Credits

Pre-requisites:EE 301

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate the characteristics of a given AC and DC servo motor.
CO2	Determine the performance of first and second order systems in time domain.
CO3	Analyze second order systems using frequency domain analysis.
CO4	Design of feedback control systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	3	-	-	3	-	-	-
CO2	1	1	2	3	-	-	3	-	-	-
CO3	1		2	3	-	-	3	-	-	-
CO4	2	2	-	3	3	-	3	-	-	-

Detailed syllabus

1. Speed-torque characteristics of AC servo-motor,
2. Study of effects of feedback,
3. Time-response of first and second order systems,
4. Frequency-response of second order system,
5. Study of PID controller,
6. Design of lag and lead compensator,
7. Study of synchro,
8. Determination of transfer function of a DC motor,
9. Design of PID controller,
10. Study of feed-forward control,
11. Design of two loop systems.

EE356	Electrical Machines Lab-II	PCC	0–0–3	2 Credits

Pre-requisites:EE 302 None

Course Outcomes: At the end of the course the student will be able to:

CO1	Predetermine the performance of induction motor by conducting no-load and blocked rotor tests.
CO2	Determine the performance of induction motor by direct load test.
CO3	Predetermine the performance of cylindrical pole synchronous machine by oc and sc test.
CO4	Determine the direct and quadrature axis reactances by conducting slip test.
CO5	Synchronisation of synchronous machine to mains and determine V and inverted V curves

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	-	-	3	-	-	-
CO2	1	2	3	2	-	-	3	-	-	-
CO3	1	2	2	2	-	-	3	-	-	-
CO4	1	2	3	2	-	-	3	-	-	-
CO5	1	2	3	2	-	-	2	-	-	-

Detailed syllabus

1. *Determination of Equivalent circuit parameters of three phase induction motor*
2. *Brake test on 3-phase induction motor*
3. *Circle diagram of 3-phase induction motor*
4. *Speed control of 3-phase induction motor*
5. *Single phase operation of 3-phase induction motor*
6. *Regulation of 3-phase alternator by Z.P.F. method*
7. *Parallel operation of alternators*
8. *Determination of V and inverted V curves of 3-phase synchronous machine*
9. *Characteristics of 3-phase Schrage motor*
10. *No load and load Characteristics of an Amplidyne*
11. *Determination of equivalent circuit parameters of single phase induction motor.*

ME435	Industrial Management	PCC	3–0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic principles, approaches and functions of management and identify concepts to specific situations.
CO2	Understand marketing management process to discuss marketing mix in formulation of marketing strategies during the life cycle of product.
CO3	Outline various techniques for improving productivity using work study.
CO4	Understand concepts of quality management and use process control charts, concepts and tools of quality engineering in the design of products and process controls
CO5	Use and distinguish basic methods/tools of inventory classification and control.
CO6	Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	1			
CO2						3	1			
CO3						3	1			
CO4						3	1			
CO5						3	1			
CO6						3	1			

Detailed syllabus

Introduction: Overview of the course, Examination and Evaluation patterns; Nature, significance and role of management in organizations.

Evolution of Industry and Principles of management: Evolution of industry and professional management; Functions of management; Organization structures; Hawthorne Experiments and informal organizational structures; Motivational theories and leadership styles.

Marketing Management: Marketing management process; 4P’s of marketing mix; Target marketing; Product life cycle and marketing strategies.

Work Study: Productivity and its role in the economy; Techniques for improving productivity; Method study; Principles of motion economy; Stop watch time study; Work sampling.

Quality Management: Dimensions of quality; Process control charts; Acceptance sampling; Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM.

Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Economic Order Quantity (EOQ); P and Q systems of inventory control.

Project Scheduling- PERT/CPM: Project activities; Network diagrams; Critical path method (CPM); Programme Evaluation and Review Technique (PERT).

Reading:

1. Koontz H and Weihrich H, Essentials of Management, 7th Ed., McGraw-Hill, New York 2007.
2. Kotler P, Marketing Management, 13th Ed., Prentice Hall of India/Pearson, New Delhi 2009.
3. Chase, Shankar, Jacobs and Aquilano, Operations and Supply Management, 12th Ed., Tata McGraw Hill, New Delhi 2010.

EE401	Solid State Drives	PCC	3–1– 0	4 Credits

Pre-requisites: EE252, EE302, EE352

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the various drive mechanisms and methods for energy conservation.
CO2	Apply power electronic converters to control the speed of DC motors and induction motors.
CO3	Evaluate the motor and power converter for a specific application.
CO4	Develop closed loop control strategies of drives

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	3	3	1	1	1	-	-	-	3
CO2	1	3	2	1	2	1	-	-	-	-
CO3	1	3	2	1	1	1	-	-	-	-
CO4	1	3	2	1	1	1	-	-	-	-

Detailed syllabus

Introduction to electric drives:

Electrical Drives, Advantages of Electric drives, Parts of Electrical Drives, Electric Motors, Power Modulators, Sources, Control unit, Choice of Electric Drives and Losses.

Dynamics of electrical drives:

Fundamental torque equation, components of load torque, load characteristics, modified torque equation, speed-torque convention & multi-quadrant operation. Equivalent values of drive parameters, load with rotational motion, loads with translational motion, measurement of moment of inertia, components of load torques, Nature and classification of load torque. Calculation of time and energy loss in transient operation, steady state stability, loads equalization.

Control of electrical drives: Modes of operation, speed control and drive classifications, closed loop control of drives.

DC Motor Drives: Starting, Braking, Speed control of DC motors using single phase fully controlled and half controlled rectifiers.
Three phases fully controlled and half controlled converter fed DC motor drives.
Chopper controlled DC drives.

Induction Motor Drives: Speed control using pole changing, stator voltage control, AC voltage controllers. Variable frequency and variable voltage control from inverter. Different types of braking, dynamic, regenerative and plugging.

Energy Conservation in Electric Drives: Losses in Electric drive systems, measurement of Energy conservation in Electric drives. Use of efficient converters, energy efficient operation of drives, Improvement of p.f., improvement of quality of supply, maintenance of motors

Reading:

1. G.K. Dubey: Fundamentals of Electric Drives –Narosa Publishers, Second edition, 2007.
2. Vedam Subramanyam: Electric Drives Concepts & Applications –Tata McGraw Hill Edn. Pvt.Ltd, Second edition 2011.
3. Nisit K.De and Prashanta K.Sen: Electric Drives, PHI., 2001
4. V. Subrahmanyam: Thyristor Control of Electric Drives, Tata McGraw Hill Edn. Pvt.Ltd, 2010.
5. Werner Leonhard: Control of Electric Drives, Springer international edition 2001.
6. Nisit K.De and Swapan K.Dutta: Electric Machines and Electric Drives, PHI learning Pvt. Ltd 2011.

EE402	HVDC and FACTS	PCC	3–1– 0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate HVDC and EHVAC transmission
CO2	Analyze converter configurations used in HVDC and list the performance metrics.
CO3	Understand controllers for controlling the power flow through a dc link and compute filter parameters
CO4	Apply impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems
CO5	Analyze and select a suitable FACTS controller for a given power flow condition

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	-	-	-	-	-
CO2	2	3	3			-	-	-	-	-
CO3	2	1	3		1	-	-	-	-	2
CO4	2	1	3	3	3	-	-	-	-	-
CO5	3	3	1		3	-	-	-	-	-

Detailed syllabus

HVDC Transmission:

DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems

Analysis of HVDC Converters:

Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms

Converter and HVDC Control:

Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control

Harmonics and Filters:

Ill effects of Harmonics, sources of harmonic generation, Types of filters –Design examples

Power Flow Analysis in AC/DC Systems:
Modelling of DC links, solutions of AC-DC Power flow

Flexible AC Transmission Systems (FACTS):
FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters

Static Shunt Compensators:
Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

Static Series Compensators:
Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Combined Compensators:
Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Reading:

1. HVDC Power Transmission Systems –Technology and System Interactions" K.R.Padiyar, New Age International Publishers
2. "Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems" Narain G.Honorani, Laszlo Gyugyi

EE411	AI Techniques in Electrical Engineering	PCC	3–0– 0	3 Credits

Pre-requisites: EE351

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand concepts of ANNs, Fuzzy Logic and Genetic Algorithm.
CO2	Remember difference between knowledge based systems and Algorithmic based systems.
CO3	Understand operation of Fuzzy Controller and Genetic Algorithm.
CO4	Apply soft computing techniques for real-world problems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3	2					

Detailed syllabus

Artificial Neural Networks:

Introduction, Models of Neuron Network-Architectures –Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning –Competitive learning-Boltzman learning, supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks.

ANN Paradigms:

Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

Fuzzy Logic:

Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy cartesion Product, Operations on Fuzzy relations –Fuzzy logic –Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods

Genetic Algorithms:

Introduction-Encoding –Fitness Function-Reproduction operators, Genetic Modeling –Genetic operators-Cross over-Single site cross over, Two point cross over –Multi point cross over-Uniform cross over, Matrix cross over-Cross over Rate-Inversion & Deletion, Mutation operator –Mutation –Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

Applications of AI Techniques:
Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Small Signal Stability (Dynamic stability), Reactive power control , Speed control of DC and AC Motors.

Reading:

1. S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.
2. 2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011
3. P.D.Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York, 1989.
4. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall,1992
5. D.E.Goldberg, Genetic Algorithms, Addison-Wesley 1999.

EE412	**Computer Methods in Power Systems**	**PCC**	**3–0– 0**	**3 Credits**

Pre-requisites: EE303, EE251

Course Outcomes: At the end of the course the student will be able to:

CO1	Design mathematical models for power system components.
CO2	Analyze and pick the best algorithm for a selected power system problem.
CO3	Generate input data suitable for load flow, fault calculations and state estimation.
CO4	Understand application of Gauss-Seidel, Newton-Raphson and Fast Decoupled methods

Mapping of course outcomes with program outcomes

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3									
CO2	3									
CO3	3									
CO4	3									

Detailed syllabus

Incidence and network matrices:

Introduction, Graphs, Incidence matrices, Primitive matrices, Types of network matrices, formation of network matrix, PI-representation of off-nominal tap transformers, Ybus by singular transformation, examples of formation of incidence matrices, formation of Ybus by inspection.

Algorithms for formation of Z-bus matrix:

Step by Step algorithm for formation of Zbus. Modification of Zbus matrix for changes in the network, example of formation and modification of Zbus matrix.

Short Circuit calculations:

Introduction, Short circuit calculations using Zbus^{012}, z_f^{abc}, y_f^{abc}, z_f^{012}, y_f^{012} matrices for various faults, example of short circuit calculations using Zbus^{012} for L-L-L and L-G faults.

Sparsity Technique in Load Flow Studies:

Introduction, Sparsity technique for Ybus and Gauss-Seidel method

Review and Comparison of Gauss-Seidal, Newton-Raphson, Fast decoupled models.

AC-DC Load Flow study and concept of Contingency analysis

Introduction of Real time control of Power System:
Introduction, linear State Estimation WLS equations, Types of measurements, D.C power flow based WLS equations, examples of D.C based WLS State Estimation, SCADA.

Transient Stability Analysis:
Representation of transmission networks, Generators and loads. Exciter and governor control system representations. Numerical Integration methods **-** Runge Kutta fourth order methods and modified Euler's method. Transient stability algorithm using modified Euler's method and fourth order Runge Kutta method.

Reading:

1. Stagg and El Abiad, Computer Methods in Power Systems Analysis, McGraw Hill ISE, 1986.
2. M.A.Pai: Computer Techniques in Power System Analysis, Tata McGraw-Hill Education-2005.
3. K.U.Rao: Computer Methods and Models in Power Systems, I.K.International Pvt.Ltd.2009.

EE413	Electric Traction	PCC	3–0– 0	3 Credits

Pre-requisites: EE252, EE302, EE352, EE401

Course Outcomes: At the end of the course the student will be able to:

CO1	Undestand track electrification systems
CO2	Determine speed time cuves, energy consumption and rating of motors
CO3	Understand motor requirement and power supply arrangement
CO4	Understand lighting requirement and radio interference

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2		3								
CO3			3							
CO4			3							

Detailed syllabus

Traction Systems:

Methods of traction Electrification, Single Phase high frequency AC system-Three phase low frequency system, Kando System, Single phase to DC system.

Traction Mechanics:

Speed-time curve, Calculation of Tractive effort requirements-Tractive effort, Speed characteristics, Power rating of traction motors, Specific energy consumption.

Traction Motors:

Desirable characteristics of traction motors, Suitability of series motor for traction, Single phase series motor, Repulsion motor, Variable frequency inverter employing SCR.

Traction Motor Control:

Control of DC traction motors, Series-parallel control, Shunt and bridge transition.

Braking:

Types of braking –Plugging, Rheostatic braking, Regenerative braking of DC and three phase induction motors.

Power Supply Arrangements:

Major equipment at sub-station, Transformer-Circuit breaker, Interrupter, Protective Systems for AC traction, Major equipment of DC sub-stations, Design considerations of sub-stations.

Rectification Equipment and Semiconductor Devices:
Cyclo-converters, Choppers for variable frequency AC and Variable voltage converters for HVDC.

Train Lighting:
Special requirements of train lighting, Methods of obtaining unidirectional polarity, Methods of obtaining constant output, Single battery System, Double battery parallel block system.

Radio Interference:
Principle of radio interference, origin of RI, Method of propagation, Factors to be considered in line design.

Reading:

1. J.B.Gupta: Utilization of Electric power 7 Electric Traction, 9th edition, S.K.kataria& Sons, 2008.
2. Andreas Steimel: Electric Traction-Motion Power and Energy Supply, OldenbourgIndustrieverlag publishers, 2007.
3. S. Rao: EHV AC & HVDC Transmission Engg. & Practice, Khanna Pub.

EE414	Switched Mode Power Conversion	PCC	3–0– 0	3 Credits

Pre-requisites: EE 352

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand isolated and non-isolated DC-DC converters and their operation in continuous conduction mode and discontinuous conduction mode.
CO2	Calculate minimum inductance, capacitance in single switch DC-DC converters. .
CO3	Apply current control and voltage control methods to regulate the output power.
CO4	Design DC-DC converters and evaluate the stability of the system

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2		1						
CO2	3	2		1						
CO3	3	2		1						
CO4	3	2		1						

Detailed syllabus

DC/DC Converters:

Basic topologies of buck, boost converters, buck-boost converters,and cuk converter, isolated DC/DC converter topologies—forward, and fly-back converters, half and full bridge topologies, modeling of switching converters.

Current Mode and Current Fed Topologies:

Voltage mode and current mode control of converters, peak and average current mode control, its advantages and limitations, voltage and current fed converters.

Resonant Converters:

Need for resonant converters, types of resonant converters, methods of control, phase-modulation technique with ZVS in full-bridge topology, series resonant converter and resonant transition converter.

Converter Transfer Functions:

Application of state-space averaging to switching converters, derivation of converter transfer functions for buck, boost, and fly-back topologies.

Power Converter Design:

Design of filter inductor & capacitor, and power transformer, Ratings for switching devices, current transformer for current sensing, design of drive circuits for switching devices, considerations for PCB layout.

Controller Design:
Introduction, mechanisms of loop stabilization, shaping E/A gain vs. frequency characteristic, conditional stability in feedback loops, stabilizing a continuous mode forward converter and discontinuous mode fly-back converter, feed-back loop stabilization with current mode control, the right-half plane zero.

Reading:

1. Ned Mohan Tore M. Undeland: Power Electronics: Converters, Applications, and Design, Edition3, John Wiley & Sons, 2007.
2. Abraham I. Pressman, “Switching Power Supply Design”, Mc Graw Hill International, Second Edition, 1999.
3. P.C. Sen: Modern Power Electronics, S. Chand-2004.
4. Andrzej M. Trzynadlowski Introduction to Modern Power Electronics, 2^{nd} Edition, illustrated Publisher John Wiley & Sons, 2010.
5. Muhammad H. Rashid, Power electronics hand book, ISBN: 81 8147 367 1.

EE441	Seminar	PCC	0–0– 3	1 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop presentation skill.
CO2	Develop communication skill.
CO3	Understand others points of view
CO4	Be aware of latest developments

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2							3			
CO3							3			
CO4										3

EE449	Project Work Part A	PCC	0–0–3	2Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify a problem of current relevance to society.
CO2	Formulate the problem and identify suitable modelling paradigm.
CO3	Analyze the problem and identify the solution methodology

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	3
CO2			3							
CO3			3							

EE451	Power Systems Laboratory	PCC	0–0– 3	2 Credits

Pre-requisites: EE303, EE353

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the performance characteristics of a long transmission line and its reactive power requirement.
CO2	Compute fault currents for faults on power system elements.
CO3	Use modern software tools for power system simulation studies.
CO4	Use AI techniques for power system studies

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2	3									
CO3				3						
CO4				3						

Detailed syllabus

1. Voltage regulation and efficiency of long transmission line.
2. Reactive power control of long transmission line.
3. A, B, C, D constants of long transmission line.
4. Operating characteristics of Static differential Relay.
5. Operating characteristics of IDMT over current relay.
6. Symmetrical component analyzer.
7. Fault studies on DC Network Analyzer.
8. Sequence reactances of power system elements and fault studies.
9. Reactive power control using Tap changing transformer.
10. Simulation of long line and reactive power control in EMTP.
11. Measurement of High AC Voltages using Sphere gap.
12. Tracking and Treeing test on surface of solid insulation.
13. Determination of breakdown strength of oil.
14. Generation of different impulse waveforms.
15. Determination of breakdown characteristics of air gap.

EE452	Power Electronics and Drives Lab	PCC	0–0– 3	2 Credits

Pre-requisites: EE401

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the operation of rectifiers, DC-DC converters. ac voltage controllers and inverter circuits.
CO2	Evaluate the various performance indices like ripple factor, THD.
CO3	Design the control circuit and the power circuit for DC-DC converters
CO4	Compare various options available for the drive circuit requirements

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2		3								
CO3	3	3		3						
CO4		3								

Detailed syllabus

List of Experiments:

1. Study of single phase fully controlled and half controlled converter with R, RL and RLE load.
2. Study of AC voltage controller using TRIAC with R and RL load.
3. Study of speed control of a separately excited DC motor.
4. Study of PWM AC-DC converter circuit.
5. Study of DC-DC Buck converter
6. Study of DC-DC Boost converter
7. Study of DC-DC Buck-Boost converter
8. Study of Parallel inverter

Reading:

1. M.H.Rashid: Power Electronics-Circuits, Devices and Applications, 3rd Edition, PHI, 2005.
2. Ned Mohan, T.M.Undeland and William P.Robbins: Power Electronics: Converters and Applications, 3rd Edition, John Wiley & Sons, 2009.

EE461	Distribution System Planning and Automation	PCC	3–0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the characteristics and components of electric power distribution systems.
CO2	Analyze and evaluate the impact of geographical, demographical and economic factors on distribution systems
CO3	Understand the components of distribution automation systems.
CO4	Design, analyze and evaluate distribution system design based on forecasted data

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2						3			3	
CO3	3									
CO4	3									

Detailed syllabus

Power sector in India:

An overview of distribution systems, Distribution system planning-issues and aspects, Introduction to Distribution system forecasting techniques, Stochastic and time series techniques for forecasting, intelligent techniques based load forecasting techniques, Definitions and importance of various terms that characterize loads, Load management and types of tariffs

Distribution transformers (DTRs):

Basic design considerations, 3-ph and 1-ph DTRs-types of connections and its relevance in operation, Need for special types of distribution transformers, Cast resin, CSP, Amorphous core DTRs, Regulation and efficiency of transformers-use of predetermined curves

Sub-transmission system:

Sub-stations site selection procedure, Sub-station capacity expansion, Location of new sub-stations and their rating, Sub-station bus schemes, VD and PL calculations for a service area with four and six feeders, VD and PL calculations for a service area with n-feeders, Characteristics of primary systems, Voltage drop (VD) and power loss (PL) calculations, Importance of power factor in distribution systems, Capacitors and their role in improving power factor

Distribution system protection:

Distribution system protection devices, Problems in distribution systems and the need for automation,

Distribution system automation (DSA):

General schematic, DSA-Hardware modules and their functions, DSA-Software modules and their functions, DSA-Alternatives in Communication media, Communication protocols for DSA schemes and need for OSA, Examples of DSA schemes, Distribution system grounding

Reading:

1. Turan Gonen: Electric power Distribution System Engineering, CRC Press, II Edition
2. A S Pabla: Electric Power Distribution, TMH, Fifth Edition
3. James A Momoh: Electric Power Distribution, Automation, Protection and Control, CRC Press

EE462	High Voltage Engineering	PCC	3– 0–0	3 Credits

Pre-requisites: EE203, EE253

Course Outcomes: At the end of the course the student will be able to:

CO1	Design the insulation of HV power equipment.
CO2	Estimate electric field intensity of different electrode configurations.
CO3	Understand the testing methods of high voltage equipment
CO4	Understand the Breakdown mechanism of Gas, Liquid and solid insulation

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2	3									
CO3				3						
CO4			3							

Detailed syllabus

Electro Static Fields, Their Control and Estimation

Electric Field intensity, Electric strength, classification of Electric Fields, control of electric Field intensity, basic equations for potential and field intensity in electrostatic fields, Analysis of electric field intensity in homogenous and multidielectric electric fields, numerical methods for estimation of electric field intensity.

Generation of High Dc and Ac Voltages

Introduction, Rectifier circuits, Cockcroft- Walton voltage multiplier circuit, electrostatic generator, generation of high ac voltages by cascaded transformers, series resonant circuit.

Generation of Impulse Voltages and Currents

Definitions, impulse generator circuits, Analysis of impulse generator circuit, multistage impulse Generator circuit, triggering of impulse generator, impulse current generation.

Measurement of High Voltages and Currents

Introduction, sphere gap, uniform field spark gap, rod gap, electrostatic voltmeter, generating voltmeter, Fortescue method, resistive and capacitive voltage dividers, measurement of high DC, AC and impulse currents.

High Voltage Testing of Electrical Equipment

Testing of overhead line insulators, Testing of cables, Testing of Bushings, Testing of power capacitors, Testing of power transformers, Testing of circuit breakers. IEC, ANSI, IEEE and Indian standards for Testing electrical equipment.

Non-Destructive Test Techniques

Measurement of resistance, measurement of dielectric constant and loss factor, High voltage Schering Bridge, measurement of large capacitances, partial discharges measuring and diagnostic techniques. Time domain and Frequency domain analysis of dielectric materials subjected to an electric field.

Breakdown Mechanism of Gaseous Liquid and Solid Insulating Materials

Introduction, Mechanism of breakdown in gases, Townsend's first ionization coefficient, cathode processes, secondary effects, Townsend's second ionisation coefficient, Townsend breakdown mechanism, streamer or kanal mechanism of spark, Paschen's law, Penning effect, Breakdown in non-uniform fields, principles of breakdown in solid and liquid dielectrics, Applications of gas, liquid and solid dielectrics.

Reading:

1. Ravindra Arora & Wolfgang Mosch: High voltage Insulation Engineering, New Age International Publishers, 2011.
2. C.L. Wadhwa: High voltage Engineering, New Age International Publishers, 2011.
3. E. Kuffel, W.S. Zaengl, J. Kuffel, High voltage Engineering Fundamentals, Newnes Publishers, 2011.
4. M.S. Naidu & Kamaraju, High voltage Engineering Fundamentals, TMH, 2008.

EE463	Electrical Machine Modelling and Analysis	PCC	3– 0–0	3 Credits

Pre-requisites: EE252, EE302

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the limitations of conventional models of electrical machines
CO2	Determine the torque produced in electrical machines using the concept of coenergy
CO3	Determine the performance of machines using reference frame theory
CO4	Select strategies to control the torque for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3		3							
CO2	3	3								
CO3		3	3							
CO4					3					

Detailed syllabus Basic
Principles for Electrical Machine Analysis

Magnetically coupled circuits:
Review of basic concepts, magnetizing inductance, Modelling linear and nonlinear magnetic circuits

Electromechanical energy conversion:
Principles of energy flow, concept of field energy and co-energy, Derivation of torque expression for various machines using the principles of energy flow and the principle of coenergy, Inductance matrices of induction and synchronous machines

Theory of DC machines:
Review of the DC machine, mathematical model of commutator, State-space model of a DC machine, reduced order model & transfer function of the DC machine, Reference Frame Theory-Concept of space vector, components of space vector, direct and quadrature axis variables

Transformation:
Types of transformation, condition for power invariance, zero-sequence component, Expression for power with various types of transformation, Transformations between reference frames, Clarke and Park's Transformations, Variables observed from various frames, Simulation studies

Theory of symmetrical Induction Machines:
Voltage and torque in machine variables, Derivation of dq0 model for a symmetrical induction machine, Voltage and torque equation in arbitrary reference frame variables, Analysis of steady-state operation, State-space model of induction machine in'd-q' variables, Simulation studies

Theory of synchronous machines:
Equations in arbitrary reference frame, Park's transformation, Derivation of dq0 model for a salient pole synchronous machine with damper windings, Torque expression of a salient pole synchronous machine with damper windings and identification of various components

Reading:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: "Analysis of Electric Machinery & Drive systems"-IEEE Press, 2002.
2. Rama Krishnan: Electric motor drives: modeling, analysis, and control, Prentice Hall, 2001.
3. Rik De Doncker, Duco W. J. Pulle, André Veltman: Advanced Electrical Drives: Analysis, Modeling, Control Springer, 2011.
4. E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery, TMH, 5th Ed.

EE464	Planning an Entrepreneurial Venture	PCC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Enable the students to learn the process and practice of entrepreneurship and new venture creation
CO2	Equip the students with conceptual frameworks for identifying entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Enable the students to explore the opportunities in the domain of Electrical, Electronics and Computer Engineering for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						2				
CO2							3	2		
CO3									2	3
CO4						3				

Detailed syllabus

Entrepreneur and Entrepreneurship:
Entrepreneurship and Small Scale Enterprises (SSE) –Role in Economic Development, Entrepreneurial Competencies, Institution Interface for SSE

Establishing the Small Scale Enterprise :
Opportunity Scanning and Identification in the domain of Electrical, Electronics and Computer Engineering, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework

Operating the Small Scale Enterprises:
Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, Organizational Relations in SSE

Reading:

1. Kuratko: New Venture Management: The Entrepreneur’s Roadmap, Pearson Education India, 2008.
2. Holt, “Entrepreneurship: New Venture Creation”, PHI (P), Ltd., 2001.

3. Lisa K. Gundry, Jill R. Kickul: Entrepreneurship Strategy: Changing Patterns in New Venture Creation, Growth, And Reinvention, and Edition illustrated Sage Publications, 2007.
4. MadhulikaKaushik : Management of New & Small Enterprises, IGNOU, Course material, 1995.
5. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
6. P.C.Jain: A Hand Book for New Enterpreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
7. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
8. J B Patel, S S Modi: A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

EE465	Power Quality	PCC	3– 0–0	3 Credits

Pre-requisites: EE352, EE303

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the power quality issues in electrical distribution network
CO2	Evaluate the severity of voltage sag, voltage swell, harmonics, and transients in distribution networks
CO3	Understand the methods to improve the power quality
CO4	Design circuits to mitigate power quality issues

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3								
CO2	3	3								
CO3	3	3								
CO4					3					

Detailed syllabus

Introduction:
Definition of Power quality, Power Quality –Voltage & Current Quality, Importance of Power Quality, Power quality Evaluation.

Terms and Definitions:
General Classes of Power quality Problems, Transients, Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage fluctuation, Power Quality Terms, CBEMA and ITI Curves.

Voltage Sags and Interruptions:
Sources of Sags and Interruptions, Estimating voltage Sag Performance, Fundamental Principles of Protection, Solution at the End-User Level, Motor –Starting Sags.

Transient over Voltages:
Sources of Transient Over voltages, Principles of Over voltage Protection, Devices for over voltage Protection, Utility Capacitor-Switching transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transients Analysis

Fundamentals of Harmonics:

Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads, Locating Harmonic Sources, Effects of Harmonic distortion, Inter harmonics, Harmonic distortion Evaluations, Principles for Controlling Harmonics, Harmonic Filter design: A Case Study, Standards of Harmonics.

Long-Duration Voltage Variations:
Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator application, Capacitors for Voltage Regulation, End-Users Capacitors Application, and Regulating Utility Voltage with distributed Resources Flicker.

Power Quality Monitoring:
Monitoring considerations, Historical Perspective of Power quality Measuring Instruments, Power Quality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of intelligent Systems, Power Quality Monitoring Standards, Monitoring considerations

Reading:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan , Marks F. Beaty and H. Wayre, Mc Graw Hill
2. Power Systems Quality Assessment, J.Arillaga, N.R.Watson, S.Clon, John Wiley
3. Power Quality, C.Sankaran, CRC Press
4. Understanding power quality problems, Math H. Bollen, IEEE press

EE466	Power System Deregulation	PCC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the developments in power system restructuring.
CO2	Identify the roles and responsibilities of service entities in the power market.
CO3	Analyze congestion management, transmission pricing, and ancillary services management

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2									3	
CO3						3				

Detailed syllabus

Overview of Key Issues in Electric Utilities:
Introduction –Restructuring models –Independent system operator (ISO) –Power Exchange - Market operations –Market Power –Standard cost –Transmission Pricing –congestion Pricing – Management of Inter zonal/Intra zonal Congestion.

OASIS: Open Access Same-Time Information System:
Structure of OASIS -Posluing of Information –Transfer capability on OASIS –Definitions Transfer Capability Issues –ATC –TTC –TRM –CBM calculations –Methodologies to calculate ATC

Electricity Pricing:
Introduction –electricity Price Volatility Electricity Price Indexes –challenges to Electricity Pricing –Construction of Forward Price Curves –Short-time Price Forecasting.

Power System Operation in a Competitive Environment:
Introduction –Operational Planning Activities of ISO-The ISO in Pool Markets –The ISO in Bilateral Markets –Operational Planning Activities of a Genco

Ancillary Services Management:
Introduction –Reactive Power as an Ancillary Service –a review –Synchronous Generators as Ancillary Service Providers.

Reading:

1. Kankar Bhattacharya, Math H.J. Boller, JaapE.Daalder, “Operation of Restructured Power System” Klum, er Academic Publisher –2001.
2. AshikurBhuiya: Power System Deregulation: Loss Sharing in Bilateral Contracts and Generator Profit Maximization, Publisher VDM Verlag, 2008.

3. Mohammad Shahidehpour, and Muwaffaqalomoush,-“Restructured Electrical Power systems” Marcel Dekker, Inc. 2001.
4. Loi Lei Lai; “Power system Restructuring and Deregulation”, Jhon Wiley & Sons Ltd., England.

EE467	Real Time Control of Power Systems	PCC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Remember the definition of power quality and different terms in power quality.
CO2	Evaluate the severity of power quality problem in a particular case.
CO3	Understand the behavior of power electronic loads
CO4	Design ways to mitigate power quality issues

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3									
CO2	3			3						
CO3	3	3								
CO4	3				3					

Detailed syllabus

Substation/ Generating Station:
Lay out of substation / Generating Station, Main Equipment in Sub Station/ Generating Station, Instrument Transformers and their importance in measurements and protection, important parameters necessary for Grid operation: Analog Points (MW, MVar, Tap Position, Voltage, Frequency), Status Points (CB Status, Isolator Status, SOE Points), Alarms. Hardware required getting these parameters to RTU: Transducers & their connectivity.

Scada Functions:
Introduction to SCADA: Grid Operation & Control, Difficulties in operating the large power systems manually, need for going to SCADA operation, advantages of SCADA operation. Data Acquisition, Monitoring and Event Processing, Control Functions, Time tagged data, Disturbance data collection and analysis, Reports and Calculations. Man –Machine Communication: Operator's Console, VDU Display and its use, Operator Dialogs, Mimic Diagram Functions, and Printing Facilities.

Remote Terminal Unit (RTU) & Communication Practices:
Major Components: RTU Panel, Interface Panel. D20M Main Processor, Analog Card, Status Card, Control Card, Modems. Types Of Communications: Power Line Carrier Communications, Microwave, Optical fibre, VSAT Communications. Types of Network Elements in LAN & WAN. Process of Data Communication.

Sub-Load Dispatch Center (SUB-LDC):
Various Equipment in Sub LDC: (a) Work Stations: details (b) FEPS: Function of FEPS (Front End Processors). (c) Routers: function of routers, interconnectivity of the equipment by LAN, Functionality and responsibilities of Sub LDC

Introduction to SCADA Protocols and Communication Standards for Electrical Power Systems:
Power System Control requirements and evolution of Protocol for Communication, Protocols - Modbus, Distributed Network Protocol (DNP), IEC 870-5 and 60870 series, Benefits from the IEC (International Electro technical Commission) communication Standards. **(Ref: www.dnp.org,www.modbus.org, www.kema.nl)**

Real Time Software:
Classification of Programs, Structure of Real time Programs, Construction Techniques & Tools, Programming Language Requirements for Process Control.

Computer Control of Electrical Power Systems:
Evolution of System Control, time scale of system control, online computer control, and Software Elements: State Estimation, Monitoring & Prediction, Generation & Load Control, Security Analysis; Software Coordination & Systems Simulation. State Load Dispatch Center (SLDC): Inter Connectivity of Sub-LDCs & SLDCs, Hierarchy of Data Transfer, Functions & Responsibilities of SLDC, Real Time Operation carried at SLDC.

Southern Regional Load Dispatch Center (SRLDC):
Functions & Responsibilities of SRLDC, Operations carried at SRLDC, Overview of SCADA, and Real Time Operation in detail.

Reading:

1. Hassan Bevrani: Robust Power System Frequency Control, Power Electronics and Power Systems, Edition illustrated Publisher Springer, 2009.
2. Michael John Howard Sterling: Power system control, Volume 6 of IEE control engineering series, Edition illustrated Publisher Peregrinus [for] the Institution of Electrical Engineers, 1978.
3. TorstenCegrell, “Power System control –Technology”, Prentice –Hall International series in Systems and control Engineering, Prentice Hall International Ltd., 1986.
4. S. Bennett and D.A. Linkens (Editors): Real –Time Computer Control, IEE Control Engineering series (24), peter Peregrinus Ltd., 1984.
5. Real –Time Systems –by C.M. Krishna and Kangg. Shin, McGraw-Hill international companies, 1997.

EE468	Renewable Energy Systems	PCC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the principles of wind power and solar photovoltaic power generation, fuel cells.
CO2	Assess the cost of generation for conventional and renewable energy plants
CO3	Design suitable power controller for wind and solar applications
CO4	Analyze the issues involved in the integration of renewable energy sources to the grid

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3								
CO2				3						
CO3	3		3		3					
CO4									3	

Detailed syllabus

Introduction:
Renewable Sources of Energy-Grid-Supplied Electricity-Distributed Generation-
Renewable Energy Economics-Calculation of Electricity Generation Costs –Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

Wind Power Plants:
Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose of the Energy Generated -General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines -Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy -Analysis of Small Generating Systems.

Photovoltaic Power Plants:
Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and

Parameters for Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy.

Fuel Cells:
The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues-Constructional Features of Proton Exchange-Membrane Fuel Cells –Reformers-Electrolyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit-Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel.

Induction Generators:
Principles of Operation-Representation of Steady-State Operation-Power and Losses Generated-Self-Excited Induction Generator-Magnetizing Curves and Self-Excitation-Mathematical Description of the Self-Excitation Process-Interconnected and Stand-alone operation -Speed and Voltage Control -Economical Aspects.

Storage Systems:
Energy Storage Parameters-Lead–Acid Batteries-Ultra Capacitors-Flywheels -Superconducting Magnetic Storage System-Pumped Hydroelectric Energy Storage -
Compressed Air Energy Storage -Storage Heat -Energy Storage as an Economic Resource.

Integration of Alternative Sources of Energy:
Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach-Integration of Multiple Renewable Energy Sources-Islanding and Interconnection Control-DG Control and Power Injection.

Interconnection of Alternative Energy Sources with the Grid:
Interconnection Technologies -Standards and Codes for Interconnection-Interconnection Considerations -Interconnection Examples for Alternative Energy Sources.

Reading:

1. Felix A. Farret, M. Godoy Simoes, “Integration of Alternative Sources of Energy”, John Wiley & Sons, 2006.
2. Solanki: Renewable Energy Technologies: Practical Guide For Beginneers, PHI Learning Pvt. Ltd., 2008.
3. D.Mukherjee: Fundamentals Of Renewable Energy Systems, New Age International publishers, 2007.
4. Remus Teodorescu, Marco Liserre, Pedro Rodríguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.
5. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

EE469	Smart Electric Grid	PCC	3– 0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the features of small grid in the context of Indian grid.
CO2	Understand the role of automation in transmission and distribution.
CO3	Apply evolutionary algorithms for smart grid.
CO4	Understand operation and maintenance of PMUs, PDCs, WAMs, and voltage and frequency control in micro grid

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3								
CO2		3								
CO3				3						
CO4		3		3	3					

Detailed syllabus

Introduction to Smart Grid:
What is Smart Grid? Working definitions of Smart Grid and Associated Concepts –Smart Grid Functions-Traditional Power Grid and Smart Grid –New Technologies for Smart Grid –Advantages –Indian Smart Grid –Key Challenges for Smart Grid.

Smart Grid Architecture:
Components and Architecture of Smart Grid Design –Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs –Transmission Automation –Distribution Automation –Renewable Integration

Tools and Techniques for Smart Grid:
Computational Techniques –Static and Dynamic Optimization Techniques –Computational Intelligence Techniques –Evolutionary Algorithms –Artificial Intelligence techniques.

Distribution Generation Technologies:
Introduction to Renewable Energy Technologies –Micro grids –Storage Technologies –Electric Vehicles and plug –in hybrids –Environmental impact and Climate Change –Economic Issues.

Communication Technologies and Smart Grid:
Introduction to Communication Technology –SynchroPhasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS).

Control of Smart Power Grid System:

Load Frequency Control (LFC) in Micro Grid System –Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid.Case Studies and Test beds for the Smart Grids.

Reading:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
3. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010.
4. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2005.

EE449	Project Work Part B	PCC	0– 0–6	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Simulate and construct systems using modern tools
CO2	Validate and analyze the results
CO3	Write a project report

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2		3								
CO3							3			

OPEN ELECTIVE COURSES

CE390	**Environmental Impact Analysis**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None.

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

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								3	3	
CO2								2		
CO3								1		
CO4							3			
CO5						3				

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid

Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain, R.K., Urban, L.V., Stracy, G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0	3 Credits

This course is not offered to Electrical Engineering students

Pre-requisites: None.

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							

Detailed syllabus:

Introduction - control system, types, feedback and its effects-linearization

Mathematical Modelling of Physical Systems. Block diagram Concept and use of Transfer function. Signal Flow Graphs- signal flow graph, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical system and importance of electronic controls

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	3							
CO2	1		3							
CO3	1	2	3							
CO4	1	3								
CO5	1		3							
CO6	1	2			2					

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch- Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M.Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H.Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	ROBUST DESIGN	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1									
CO2	2									
CO3	2				3					
CO4		2		3						
CO5		2								

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & Anova, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

ME392	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3			2	
CO2						3		3	2	
CO3						3			2	
CO4						3			2	
CO5							3		2	
CO6						3			2	

Detailed syllabus

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprsies**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1							
CO2	2	1								
CO3	2	2	1							
CO4	3		2							

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, 4th Edn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rd Edn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, 6th Edn, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems – 4th Edn, MGH, New York, 2002.

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2							
CO2			2		2					
CO3			2							
CO4			2							

Detailed syllabus

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.

Case study-Industry Application of Microcontrollers

Reading:

1. Barry B.Brey: Intel Microprocessor Architecture, Programming and Interfacing-8086/8088,80186,80286,80386 and 80486, PHI,1995.
2. Muhammad Ali Mazidi and Mazidi: The 8051 Microcontrollers and Embedded systems, PHI, 2008
3. Intel and ARM Data Books on Microcontrollers.

MM390	METALLURGY FOR NON-METALLURGISTS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the characteristics and usefulness of metals and alloys.
CO2	Differentiate metals and alloys and their fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							

Detailed Syllabus:

Introduction to Metallurgy:

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening

Discovering Metals: Overview of Metals, Modern Alloy Production

Fabrication and Finishing of metal products: Metal Working and Machining

Testing of Metals: Both Destructive and Non-Destructive, Inspection and Quality Control of Metals

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, Nonferrous Metals

Heat Treatment: Annealing, Normalizing, Hardening, Tempering

Corrosion and its Prevention: Electro chemical considerations, Corrosion Rates, Passivity, Environmental Effects, Forms of Corrosion, Corrosion Environments, Oxidation; Durability of Metals and Alloys

The material selection processes: Case studies

Reading:

1. M. F. Ashby: Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. Reza Abbaschian, Lara Abbaschian, R E Reed-Hill: Physical Metallurgy Principles, Affiliated East-West Press, 2009.
4. V Raghavan: Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI, 2006

CH390	Nanotechnology and Applications	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand the properties of Nano-materials and applications
CO2	Apply chemical engineering principles to Nano-particle production
CO3	Solve the quantum confinement equations.
CO4	Characterize Nano-materials.
CO5	Scale up the production Nanoparticles for Electronics and Chemical industries.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.

Nano inroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press
5. Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

CH391	Industrial Safety and Hazards	OPC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and preventive measures.
CO4	Assess the risks using fault tree diagram.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	
CO2									3	
CO3									3	3
CO4									3	

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk , Public Perceptions ,The Nature of the Accident Process ,Inherent Safety.

Industrial Hygiene- Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models- Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.

Fires and Explosions- The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO4	Create GUI based applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							
CO5			3							

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling-event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, “Understanding object-oriented programming with Java”, Pearson,
2. Herbert Schildt, “ The complete reference Java 2”, TMH,

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: Chemistry

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

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technology
CO4	Address non-renewable energy challenges

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3			3	3
CO2		2	2						3	3
CO3		2	2						3	3
CO4										

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity.

Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processes - Irreversibility of energy – Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine cycle, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.

Biomass fuels, market barriers of biomass fuels, biomass fuel standerdization, biomass fuel life cycle, Sustainability of biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; Estimation of dry flue gases for known fuel composition; Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O_2, CO_2, CO, NOx, SOx).

Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Reading:

1. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st Edition, Springer, 2009.
2. Jay Cheng, Biomass to Renewable Energy Processes, 1st Edition, CRC press, 2009.
3. Samir K. Khanal, Rao Y. Surampally, 1st edition, American Society of Civil Engineers, 2010.

SM390	MARKETING MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3	2			
CO2						3	2			
CO3						3	2			
CO4										

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior-Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, 13th Edition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3								
CO2		3								
CO3		3								
CO4		3								
CO5		3								

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	**FUZZY MATHEMATICS AND APPLICATIONS**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None.

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

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Mapping of course outcomes with program outcomes

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1				3						
CO2				3						
CO3				3						
CO4				3						
CO5				3						

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

Fuzzy Relations (FR): Introduction, Operations on FR, □-cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										3
CO2										3
CO3							2			3
CO4										3
CO5										3
CO6										3

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic non invasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design , John Wiley,3rd Ed. 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4th Ed., Prentice Hall India, 2001

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							
CO5			3							

Detailed Syllabus:

Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nano tubes(CNT).Synthesis, preparation of nanotubes, nano sensors, Quantum dots, nano wires,nano biology, nano medidcines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopeadiac implants, dental materials.

Composites: General characteristics of composites , composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices(CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets..

Reading:

1. T.Pradeep, Nano: The Essentials; TaTa McGraw-Hill,2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press
3. Krishan K Chawla, Composite Materials; 2nd Ed., Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Characterize materials using ultraviolet and visible absorption and fluorescence techniques
CO2	Analyze materials, minerals and trace samples using atomic absorption, emission and X-ray fluorescence techniques
CO3	Analyze environmental, industrial, production-line materials by liquid, gas and size-exclusion chromatographic techniques.
CO4	Characterize interfaces and traces of surface adsorbed materials using electro-analytical techniques
CO5	Understand principles of thermogravimetry and differential thermal analyses.
CO6	Characterize chemical, inorganic and engineering materials using analytical techniques

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3						
CO5				3						
CO6				3						

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.
Atomic spectrometry, atomic absorption, X-ray fluorescence methods Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, Instrumentation, quantitative analysis.
Separation techniques Solvent extraction, Principle, Extraction of solutes, Soxhlet extraction

Chromatography methods Gas chromatography, High performance liquid chromatography, Size exclusion chromatography, Principle, Basic instrumentation, Capillary Electrophoresis: Principle and application.
Thermoanalytical methods Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations.
Electroanalytical methods Coulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric sensors, Applications.
Spectroscopic methods Molecular absorption, Woodward rules, applications, Infra red absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications.
Mass spectrometry Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Mendham, Denny, Barnesand Thomas, Vogel: Text book of Quantitative Chemical Analysis, Pearson Education, 6th Edition, 2007.
2. Skoog, Holler and Kouch, Thomson, Instrumental methods of chemical analysis, 2007.
3. Willard, Meritt and Dean, Instrumental methods of chemical analysis, PHI, 2005.

CY391	CHEMICAL ASPECTS OF ENERGY SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand traditional and alternative forms of energy
CO2	Understand energy production, storage, distribution and utilization.
CO3	Model environmental impacts of energy generation and conservation
CO4	Apply concepts of engineering design to energy challenges

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								3		3
CO2								3		3
CO3								3		3
CO4										3

Detailed Syllabus:

Energy as the Key of Civilisation; Thermochemistry of Energy Sources and Kinteics of Energy Tapping; Conventional and Finite Energy Sources; Coal Based Energy Sources and Coal Carbonisation; Petroleum and Natural Gas; Biomass and Gobar Gas; Primary and Secondary Batteries, Reserve Batteries, Solid State and Molten Solvent Batteries, Lithium Ion Batteries;, Solar Energy Harnessing, Photogalvanic and Photovoltaic Energy Storage; Fuel Cells; Hydrogen as Future Fuel; Photochemical Water Cleavage; Green Energies.

Reading:

1. Tokio Ohta, Energy Systems, Elsevier Science, 2000.
2. R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy Systems, Universities Press, 1998

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2							3			
CO3							3			
CO4							3			
CO5							3			

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English. Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview Handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody Fourth Edn. Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009

CE440	BUILDING TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.
Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans.
CO2	Identify effective measures for fire proofing, damp proofing, and thermal insulation.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify different materials, quality and methods of fabrication & construction.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								2	3	
CO2								2	3	
CO3		3						2	3	2
CO4								2	3	

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance.

Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building

Termite proofing: Inspection, control measures and precautions, Lighting protection of buildings: General principles of design of openings, Various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication.

Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE 440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

This course is not offered to Electrical Engineering students

Pre-requisites: None

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

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Understand conceptual frameworks for identifying entrepreneurial opportunities and for preparation of business plan
CO3	Explore opportunities for launching a new venture
CO4	Identify functional management issues of running a new venture

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						2				
CO2							3	2		
CO3									2	3
CO4						3				

Detailed syllabus:

ENTREPRENEUR AND ENTREPRENEURSHIP:
Entrepreneurship and Small Scale Enterprises (SSE) – Role in Economic Development, Entrepreneurial Competencies, Institution Interface for SSE.

ESTABLISHING THE SMALL SCALE ENTERPRISE:
Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.

OPERATING THE SMALL SCALE ENTERPRISES:
Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, Organizational Relations in SSE.

Reading:

1. Kuratko: New Venture Management : The Entrepreneur’s Roadmap, Pearson Education India, 2008.
2. Holt, “Entrepreneurship: New Venture Creation”, PHI(P), Ltd.,2001.
3. Lisa K. Gundry, Jill R. Kickul: Entrepreneurship Strategy: Changing Patterns in New Venture Creation, Growth, and Reinvention, Sage Publications, 2007.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	2
CO2		3								
CO3		3								
CO4		3								
CO5		3								
CO6										

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources,Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Pro

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTAION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2				3						
CO3				3						
CO4				3						

Detailed syllabus

Measurement And Error: Sensitivity, Resolution, Accuracy and precision, Absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.

Instruments: D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.

Transducers (Qualitative Treatment Only): Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.

General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, 3/e, Oxford, 2013.

MM440	MATERIALS FOR ENGINEERING APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Correlate processing, microstructure and properties of materials.
CO2	Understand behaviour of materials under various conditions.
CO3	Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.
CO4	Identify suitable materials for engineering applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3	3						
CO4			3	3						

Detailed Syllabus:

Materials Science and Engineering Materials, Classification of Materials and Properties: Mechanical, Dielectric, Magnetic and Thermal

Metallurgical Aspects of Materials: Structure of Metals and Alloys, Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals, Significance of microstructural features

Heat Treatment: effect of cooling and heating rates and ageing materials for mechanical load bearing applications

Corrosion Resistant Materials: Some important Metals, Alloys, Ceramics and Polymers

Materials for Electrical Applications: Conductors, Dielectrics, insulators

Materials for Civil Engineering Applications

Materials for Biomedical applications: Steels, Ti and its alloys, Ni-Ti alloys, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products

Reading:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

CH440	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze the effects of pollutants on the environment.
CO2	Understand meteorological aspects of air pollution
CO3	Understand air pollution control methods
CO4	Select treatment technologies for water/wastewater/solid waste.
CO5	Design unit operations for pollution control.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	
CO2									3	
CO3									3	
CO4									3	
CO5									3	

Detailed Syllabus:

Introduction: Biosphere, hydrological cycle, nutrient cycle, consequences of population growth, pollution of air, water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, emission sources, behavior and fate of air pollutants, effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants.

Air pollution control methods & equipment: Control methods, source correction methods, cleaning of gaseous effluents, particulate emission control, selection of a particulate collector, control of gaseous emissions, design methods for control equipment.

Water pollution: Water resources, origin of wastewater, types of water pollutants and there effects.

Waste water sampling, Analysis and Treatment: Sampling, methods of analysis, determination of organic matter, determination of inorganic substances, physical characteristics, bacteriological measurement, basic processes of water treatment, primary treatment, secondary treatment, advanced wastewater treatment, recovery of materials from process effluents.

Solid Waste Management: Sources and classification, public health aspects, methods of collection, disposal Methods, potential methods of disposal.

Hazardous Waste Management: Definition and sources, hazardous waste classification, treatment methods, disposal methods.

Reading:

1. Rao C.S. – Environmental Pollution Control Engineering- Wiley Eastern Limited, India, 1993.
2. Noel de Nevers- Air Pollution and Control Engineering- McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke - Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2004.
4. Rao M.N. and Rao H.V.N - Air Pollution, Tata – McGraw Hill Publishing Ltd., 1993.
5. De A.K - Environmental Chemistry, Tata – McGraw Hill Publishing Ltd., 1999.

CH441	FUEL CELL TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Understand construction and operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2		3								
CO3				3						
CO4				3						

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.
3. F. Barbir, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications

CS440	Management Information Systems	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2			3							
CO3		3								
CO4								3		
CO5							3		3	3

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Business, The Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data

Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

Reading:

1. Kenneth J Laudon, Jane P. Laudon, *Management Information Systems*, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, *Management Information Systems*, 3rd Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3						
CO2		3								
CO3		3								
CO4	3									

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; Piezoelectric transducers.

Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, 1st Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						3		3	3	
CO2						3		3	3	
CO3						3		3	3	

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques,
Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management Development, Performance Appraisal and Employee Compensation, Factors Influencing Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH., 2010.
2. Garry Dessler and Biju Varkkey ,Human Resource Management, PEA., 2011.
3. Noe & Raymond ,HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2							
CO2	3	2	2							
CO3	3	2	2							
CO4	3	2	2							

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	2							
CO2	2	1								
CO3	2	1	2							
CO4	2									

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems : Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degenracy in Transportation problems.

Queueing Theory : Poisson process and exponential distribution. Poisson queues - Model (M/M/1):(∞/FIFO) and its characteristics.

Elements of Inventory Control : Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S. Chand & Co., 2006

2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo : Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3								
CO2		3								
CO3		3								
CO4		3								

Detailed Syllabus:

General properties of Nano materials : Origin of nanotechnology. Classification of nanomaterials. Fullerene,carbon, Nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase,Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants : Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes , Biomaterials an introduction; 3rd Ed., Springer, 2007
2. Sujatha V Bhat , Biomaterials; 2nd Ed., Narosa Publishing House, 2006.

CY440	CORROSION SCIENCE	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the electrochemical Principles of Corrosion.
CO2	Apply eight forms of corrosion to industrial problems.
CO3	Evaluate corrosion rates for industrial problems
CO4	Evaluate the corrosion rates of steel in RCC under corrosive environments.
CO5	Perform case studies using microbially induced corrosion of metals.
CO6	Perform case studies using appropriate methods of corrosion control of metals and alloys

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							1
CO2			3							1
CO3			3							1
CO4			3							1
CO5			3							1
CO6			3							1

Detailed Syllabus:

Understanding Corrosion:

Types of corrosion: uniform corrosion, Galvanic corrosion, pitting corrosion, stress corrosion cracking, corrosion fatigue, stray current corrosion, selective leaching, microbial corrosion Pourbaix potential-pH diagrams for iron, for aluminium, limitations of Pourbaix diagram Passivity- characteristics of passivation and the Flade potential, Theories of passivity, passive-active cells, critical pitting potential, Anodic protection and transpassivity.

Methods of corrosion monitoring:

Polarisation and corrosion rates, polarisation diagrams of corroding metals, calculation of corrosion rates from polarization data. Electrochemical impedance spectroscopy: Nyquist plots, Bode plots, simple equivalent circuits for fitting the impedance data, calculation of corrosion parameters from impedance measurements. Electrochemical cell assembly for polarization and impedance studies. Gravimetric method of determination of corrosion rates.

Measurement of corrosion rates of carbon steel in reinforced cement concrete, Corrosion rates of metals due to micriobially induced corrosion .

Methods of corrosion prevention and control:

Cathodic protection; By impressed current, By the use of sacrificial anodes, combined use with coatings, Advances in cathodic protection.

Metallic coatings: Methods of application, Electroplating, Electroless plating, specific metal platings like Cu, Ni and Cr.

Inhibitors and passivators: Picking inhibitors, vapour phase inhibitors, Inhibitors for cooling water systems, understanding of action of inhibitors through polarization and impedance.

Corrosion prevention and control strategies in different industries – case studies

Reading:

1. R. Winston Revie, Herbert H. Uhlig, Corrosion and Corrosion control, 4th edition, Wiley-Interscience, 2007
2. Mc Cafferty and Edward, Introduction to Corrosion Science, 1st Edition, Springer, 2010.
3. Mars G. Fontana, Corrosion Engineering, 3rd edition, Tata McGraw- Hill, New Delhi, 2008.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the state of art synthesis of nano materials
CO2	Characterize nano materials using ion beam, scanning probe methodologies, position sensitive atom probe and spectroscopic ellipsometry.
CO3	Analyze nanoscale structure in metals, polymers and ceramics
CO4	Analyze structure-property relationship in coarser scale structures
CO5	Understand structures of carbon nano tubes.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							2
CO2			3							2
CO3			3							2
CO4			3							2
CO5			3							2

Detailed Syllabus:

Introduction: Scope of Nano science and nanotechnology, Nano science in nature, classification of nanostructured materials, importance of nano materials.

Synthetic Methods: Chemical Routes (Bottom-Up approach):- Sol-gel synthesis, micro emulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis. Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization:

Diffraction Technique: - Powder X-ray diffraction for particle size analysis.

Spectroscopy Techniques: - Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement.

Electron Microscopy Techniques:- Scanning electron microscopy (SEM) and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM).

BET method for surface area determination.

Dynamic light scattering technique for particle size analysis.

Reading:

4. T. Pradeep, NANO: The Essentials: McGraw-Hill, 2007.
5. B. S. Murty, P. Shankar, Baldev Rai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology: Univ. Press, 2012.
6. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications: Imperial College Press, 2007.
7. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology: Narosa Pub., 2010.
8. Manasi Karkare, Nanotechnology: Fundamentals and Applications: IK International, 2008.
9. C. N. R. Rao, Achim Muller, K.Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2							3			
CO3							3			
CO4							3			
CO5							3			
CO6							3			

Detailed Syllabus:

Importance of Corporate communication - Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication- Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication- Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility- Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette- Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills - Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles - Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohanand Meera Banerji, Developing Communication Skills: Macmillan Publishers India, 2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill, 2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999