DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF EXAMINATION
AND
COURSE CURRICULUM

B.Tech. (ELECTRICAL ENGINEERING)

CONTENT

SCHEME FOR B.TECH. FIRST SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	AM-101	Mathematics-I	3-1-0	10	20	70	100	4H
TH2	HU-102	Communication Skills	2-1-0	10	20	70	100	3H
TH3	AP- 103	Applied Physics-I	3-1-0	10	20	70	100	4H
TH4	AC-104	Applied Chemistry	3-1-0	10	20	70	100	4H
TH5	EE- 105	Electrical Sciences	3-1-0	10	20	70	100	4C
TH6	IT- 106	Fundamentals of Information Technology	2-1-0	10	20	70	100	3A
PR1	AP- 107	Applied Physics-I Lab	0-0-2	30		70	100	2H
PR2	AC-108	Applied Chemistry Lab	0-0-2	30		70	100	2H
PR3	EE- 109	Electrical Sciences Lab	0-0-2	30		70	100	2C
PR4	IT- 110	Information Technology Lab	0-0-2	30		70	100	2A
							1000	**30**

L: Lecture T: Tutorial P: Practical
IA: Internal Assessment MS: Mid Semester ES: End Semester

SCHEME FOR B.TECH. SECOND SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	AM-111	Mathematics-II	3-1-0	10	20	70	100	4H
TH2	EN- 112	Environmental Sciences	2-0-0	10	20	70	100	2A
TH3	AP- 113	Applied Physics-II	3-1-0	10	20	70	100	4H
TH4	AP/AC -114	Engineering Materials	3-1-0	10	20	70	100	4H
TH5	ME-115	Basic Mechanical Engineering	3-1-0	10	20	70	100	4A
TH6	CO- 116	Programming Fundamentals	2-0-0	10	20	70	100	2A
PR1	AP- 117	Applied Physics-II Lab	0-0-2	30		70	100	2A
PR2	CO- 118	Programming Lab	0-0-2	30		70	100	2A
PR3	ME-119	Engineering Graphics	0-0-3	30		70	100	3A
PR4	PE- 120	Mechanical Workshop	0-0-3	30		70	100	3A
		TOTAL	**30 hrs**				**1000**	**30**

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

SCHEME FOR B.Tech. THIRD SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	*EE-201	Electronic Devices and Circuits	3-1-0	10	20	70	100	4C
TH2	*EE-202	Electrical Machines-I	3-1-0	10	20	70	100	4C
TH3	*EE-203	Network Analysis and Synthesis	3-1-0	10	20	70	100	4C
TH4	EE-204	Power Plant Engineering	3-1-0	10	20	70	100	4A
TH5	*EE-205	Electrical and Electronic Measurements	3-1-0	10	20	70	100	4C
TH6	*EE-206	Engineering Economics	3-0-0	10	20	70	100	3H
PR1	*EE-207	Electronic Devices and Circuits Lab.	0-0-2	30		70	100	2C
PR2	*EE-208	Electrical and Electronic Measurement Lab	0-0-2	30		70	100	2C
PR3	*EE-209	Electrical Machines-I Lab.	0-0-2	30		70	100	2C
PR4	*EE-210	Term Paper-I	0-0-1	100			100	1C
		TOTAL	**30 hrs**				**1000**	**30**

Subjects marked with asterisk (*) are common with EEE

There will be no end semester examination in term paper. It will be evaluated on the basis of presentation and continuous evaluation, for which a separate slot in time-table will be allocated.

SCHEME FOR B.Tech. FOURTH SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	*EE- 211	Linear Integrated Circuits	3-1-0	10	20	70	100	4C
TH2	EE- 212	Control Systems-I	3-1-0	10	20	70	100	4C
TH3	*EE- 213	Digital Circuits & Systems	3-1-0	10	20	70	100	4C
TH4	EE- 214	Power Systems –I	3-1-0	10	20	70	100	4C
TH5	*EE- 215	Electrical Machines-II	3-1-0	10	20	70	100	4C
TH6	*EE-216	Electromagnetic Field Theory	3-0-0	10	20	70	100	3C
PR1	*EE- 217	Linear Integrated Circuits Lab	0-0-2	30		70	100	2C
PR2	EE- 218	Power Systems- I Lab	0-0-2	30		70	100	2C
PR3	*EE- 219	Electrical Machines- II Lab	0-0-2	30		70	100	2C
PR4	#EE- 220	Term Paper-II	0-0-1	100			100	1C
		TOTAL	**30 hrs**				**1000**	**30**

Subjects marked with asterisk (*) are common with EEE

There will be no end semester examination in term paper. It will be evaluated on the basis of presentation and continuous evaluation, for which a separate slot in time-table will be allocated.

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

SCHEME FOR B.Tech. FIFTH SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	*EE- 301	Power Electronics	3-1-0	10	20	70		
TH2	EE- 302	Principles of Communication	3-1-0	10	20	70		
TH3	EE- 303	Power Systems-II	3-1-0	10	20	70		
TH4	EE- 304	Control Systems-II	3-1-0	10	20	70		
TH5	*EE-305	Microprocessor and Applications	3-1-0	10	20	70		
PR1	*EE- 306	Control Systems Lab	0-0-2	30		70		
PR2	*EE- 307	Digital Electronics & Microprocessor Lab	0-0-2	30		70		
PR3	EE- 308	Power Systems- II Lab	0-0-2	30		70		
PR4	EE- 309	Minor Project-I	0-0-4	60		140		
		TOTAL	**30 hrs**				**1000**	**30**

Subjects mark with asterisk (*) are common with EEE
Note: There shall be an Industrial Training of 4 weeks at the end of fifth semester, during winter vacation, which will be evaluated during sixth semester examinations.

SCHEME FOR B.Tech. SIXTH SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	*EE-311	Electrical Drives	3-1-0	10	20	70	100	4C
TH2	*EE-312	Electrical Machines-III	3-1-0	10	20	70	100	4C
TH3	EE-313	Power System Operation and Control	3-1-0	10	20	70	100	4C
TH4	EE-314	Instrumentation	3-1-0	10	20	70	100	4C
TH5	EE-315	Power Electronic Applications to Power Systems	3-1-0	10	20	70	100	4C
PR1	*EE-316	Power Electronics and Electrical Drives Lab	0-0-2	30		70	100	2C
PR2	EE-317	Electrical Machines-III / Power System Operation and Control Lab	0-0-2	30		70	100	2C
PR3	EE-318	Minor Project-II	0-0-4	60		140	200	4M
PR4	EE-319	Viva Voce Examination on V Semester Industrial Training	--	30		70	100	2M
		TOTAL	**28 hrs**				**1000**	**30**

Industrial Training (Durations six weeks in Summer vacation at the end of VIth semester)
Subjects mark with asterisk (*)are common with EEE

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

Note:
- Industrial training of 4 weeks during winter vacation after 5th Semester and 8 Weeks during summer vacation after 6th Semester.

SCHEME FOR B.Tech. SEVENTH SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	EE- 401	Design of Power Apparatus	3-1-0	10	20	70	100	4C
TH2	EE- 402	Switchgear and Protection	3-1-0	10	20	70	100	4C
TH3	EE- 403	Elective- I	3-1-0	10	20	70	100	4C
TH4	EE- 404	Open Elective -I	3-1-0	10	20	70	100	4C
PR1	EE- 405	Design of Power Apparatus Lab	0-0-3	30		70	100	3C
PR2	EE- 406	Switchgear and Protection Lab	0-0-3	30		70	100	3C
PR3	EE- 407	Viva Voce Examination on VI Semester Industrial Training	- - -	30		70	100	4M
PR4	EE- 408	Major Project-I	0-0-4	90		210	300	4M
		TOTAL	**26 hrs**				**1000**	**30**

SCHEME FOR B.Tech. EIGHTH SEMESTER (ELECTRICAL ENGINEERING)

S.No.	Course No.	Subject	L-T-P	Evaluation			Total Marks	Credit Type
				IA	MS	ES		
TH1	EE- 411	DSP and its Applications to Electromechanical Systems	3-1-0	10	20	70	100	4C
TH2	EE- 412	Elective- II	3-1-0	10	20	70	100	4C
TH3	EE- 413	Open Elective - II	3-1-0	10	20	70	100	4C
PR1	EE- 414	DSP Lab	0-0-3	30		70	100	3C
PR2	EE- 415	Elective - II Lab	0-0-3	30		70	100	3C
PR3	EE- 416	Major Project-II	0-0-10	120		280	400	10M
PR4	EE- 417	Seminar / Report	0-0-2	100			100	2C
		TOTAL	**30 hrs**				**1000**	**30**

Elective-I	**Open Elective I**
EE 403-1 Flexible AC Transmission Systems	EE 404-1 Automotive Systems
EE 403-2 SCADA & Energy Management Systems	EE 404-2 Intelligent Instrumentation
EE 403-3 Microwave Engineering	EE 404-3 Advanced Analog Circuit Design
EE 403-4 High Voltage Engineering	EE 404-4 Restructured Power Systems
EE 403-5 Power Plant Instrumentation	EE 404-5 Intellectual Property Rights and Entrepreneurship
EE 403-6 Microcontroller and Embedded Systems	EE 404-6 Biomedical Instrumentation
EE 403-7 Electric Traction and High Power Drives	EE 404-7 Advanced Control Systems
EE 403-8 Robotics and Mechatronics	EE 404-8 Non Conventional Energy Systems
EE 403-9 Data Communication & Computer Networks	EE 404-9 Digital & Optical Communication Systems
Elective-II	**Open Elective II**
*EE 412-1 Distributed Generation Systems	*EE 413-1 Database Management Systems
*EE 412-2 Switched Mode Power Supplies	*EE 413-2 Operating System Design
*EE 412-3 Power Quality and Energy Conservation	EE 413-3 Optimal Control Theory
EE 412-4 Power System Dynamics and Stability	*EE 413-4 Active & Passive Network Synthesis
*EE 412-5 Smart Grid	*EE 413-5 Computer Control of Processes
EE 412-6 Utilization of Electrical Energy	EE 413-6 Reliability Engineering
EE 412-7 HVDC Transmission	*EE 413-7 Artificial Intelligence and Expert Systems
*EE 412-8 Digital Image Processing	*EE 413-8 Digital System Design
*EE 412-9 Electrical Storage Systems	*EE 413-9 Filter Design
*EE 412-10 Microwave Integrated Circuits	*EE-413-10 VLSI Design
EE 412-11 Energy Auditing, Conservation and Management	*EE 413-11 Antenna & Wave Propagation

Subjects mark with asterisk (*)are common with EEE

A Allied Engineering
C Core (include major project and practical training also)
H Humanities, Social Studies and Basic Sciences
M Mandatory

Note:

- Industrial training of 4 weeks during winter vacation after 7th Semester and 8 Weeks during summer vacation after 8th Semester.

AM-101 Mathematics – I	L T P	Credits
	3 1 0	4

UNIT I

Infinite series: Tests for convergence of series (comparison, ratio, root, integral, Raabe's, logarithmic), Alternating series, Absolute convergence, Conditional convergence.

UNIT II

Calculus of single variable: Taylor's & Maclaurin's expansion, Radius of curvature, applications of definite integral to area, arc length, surface area and volume (in Cartesian, parametric and polar co-ordinates).

UNIT III

Calculus of several variables: Partial differentiation, Euler's theorem, total differential, Taylor's theorem, Maxima-Minima, Lagrange's method of multipliers, Application in estimation of error and approximation.

UNIT IV

Multiple Integrals: Double integral (Cartesian and polar co-ordinates), change of order of integration, triple integrals (Cartesian, cylindrical and spherical co-ordinates), Gamma and Beta functions. Applications of multiple integration in area, volume, centre of mass, and moment of inertia.

UNIT V

Vector Calculus: Continuity and differentiability of vector functions, Scalar and vector point function, Gradient, Directional derivative, divergence, curl and their applications. Line integral, surface integral and volume integral, applications to work done by the force . Applications of Green's, Stoke's and Gauss divergence theorems.

Text Books/Reference Books:

1. "Advanced Engineering Mathematics" by Alan Jeffery ; Academic Press
2. "Calculus and Analytic Geometry" by Thomas/Finney; Narosa.
3. "Advanced Engineering Mathematics" by Kreyszig; Wiley.
4. "Advanced Engineering Mathematics" by Taneja ; I K international
5. "Advanced Engineering Mathematics" by Jain/Iyenger; Narosa.

HU-102 Communication Skills	L T P	Credits
	2 1 0	3

UNIT I

Functional English:

(A) Parts of speech; Tense and concord; Conditional clauses; Question tags & short responses; Punctuation; Common errors.

(B) Vocabulary and Usage: Synonyms & Antonyms; One word substitutions; Words often confused; Idioms / Idiomatic expressions.

UNIT II

Basics of Writing:

(A) Presentation of Technical Information: Technical description of simple objects, tools, appliances; Processes and operations; Scientific Principles; Definitions ; Interpretation of Visual Data (graph, charts etc)

(B) Writing of: Paragraph; Summary and Abstract; Taking and Making Notes.

(C) Comprehension of Unseen Passages based on reading exercises like Skimming, Scanning and Inference making.

UNIT III

Oral Communication: Phonetics: Speech Sounds and their articulation; Phonemes, syllable, Stress, Transcription of Words and Simple Sentences; Presentation and Seminar; Language Lab Practice for Oral Communication.

UNIT IV

Texts for Appreciation and Analysis:

(A) Wings of Fire by APJ Abdul Kalam

(B) The Fortune at the Bottom of the Pyramid by C.K. Prahalad.

(C) The Branded (Uchalya) by Laxman Gaikwad

(D) Geetanjali by Ravindranath Tagore.

Text Books/Reference Books:

1. Day, Robert A. Scientific English: A Guide for Scientists and Other Professionals. UP.
2. Maison Margaret, Examine Your English, New Delhi: Orient Longman.
3. Tikoo M.L., A.E. Subramaniam and P.R. Subramaniam. Intermediate Grammar Usage and Composition. Delhi: Orient Longman.
4. Weiss, Edmond H. Writing Remedies: Practical Exercises for Technical Writing. University Press.
5. Lesikar and Flatley. Business Communications. New Delhi, Biztantra Press.
6. O'Connor, Better English Pronunciation, Cambridge: Cambridge University Press.
7. Gaikwad, Laxman, The Branded, Delhi: Sahitya Akademi.
8. Kalam, APJ Abdul, Wings of Fire, Delhi: University Press.
9. C.K. Prahalad, The Fortune at the Bottom of the Pyramid, Wharton School Publishing.
10. Rabindranath Tagore, Gitanjali, Filiquarian Publishing, LLC.

AP – 103 Applied Physics - I	L T P	Credits
	3 1 0	4

UNIT I

Relativity : Review of concepts of frames of reference and Galilean transformation equation, Michelson – Morley experiment and its implications, Einstein's special theory of relativity, Lorentz transformation equations, Law of addition of velocities, Mass variation with velocity, Concept of energy and momentum, Mass energy relation.

UNIT II

Oscillations, waves : Damped and forced oscillations, Resonance (amplitude and power), Q – factor, Sharpness of resonance. Equations of longitudinal and transverse waves and their solutions, Impedance, Reflection and transmission of waves at a boundary, Impedance matching between two medium.

UNIT III

Physical optics: Interference by division of wave front and amplitude, Multiple beam interference and Fabry-Perot interferometer, Fresnel diffraction through a straight edge, Fraunhoffer diffraction, Zone plate, single slit and N-slit / grating, Resolving power of telescope, prism and grating. Polarization by reflection and by transmission, Brewster's law, Double refraction, elliptically and circularly polarized light, Nicol prism, Quarter and half wave plates.

UNIT IV

Optical Instruments: Cardinal points of co-axial lens systems, spherical and chromatic aberrations and their removal, Huygens and Ramsden's eyepiece.

UNIT V

Laser optics: Coherence and coherent properties of laser beams, Brief working principle of lasers, Spontaneous and stimulated emission, Einstein's co-efficient, Ruby laser, He-Ne laser.

UNIT VI

Optical Fiber: Classification of optical fibers, Refractive index profile, Core cladding refractive index difference, Numerical aperture of optical fiber, Pulse dispersion in optical fiber (ray theory).

Text Books/Reference Books:

1. "Physics of Vibrations and Waves" by H.J. Pain.
2. "Vibrations and Waves" by A.P. French.
3. "Perspective of Modern Physics" by Arthur Beiser.
4. "Optics" by A. Ghatak.
5. Berkley Physics Course Vol – 1.

AC-104 Applied Chemistry	L T P	Credits
	3 1 0	4

UNIT I

(a) Conventional Analysis: Volumetric Analysis, Types of titrations, Theory of indicators.

(b) Spectral Analysis: Electromagnetic radiation, Lambert-Beer's Law, UV-VIS, IR, instrumentation & applications.

UNIT II

Thermal Methods of Analysis: Principle, working and applications of Thermo-gravimetry, Differential thermal analysis and Differential scanning calorimetry.

UNIT III

(a) Polymers: Monomer & polymer, functionality and Degree of Polymerization. Mechanism of polymerization. Molecular weights of polymers. Methods of polymerization. Industrial production of PE and PF resins. Industrial applications of polymers.

b) Bio-molecules: Classification, Structure, physical and chemical properties of Amino-acids, Peptides and Proteins, Carbohydrates, Cellulose and its derivatives, RNA, DNA. Introduction to Bio-degradable Polymers.

UNIT IV

Electrochemistry : Electrochemical cells, components, characteristics of batteries. Primary and Secondary battery systems, Zinc-Carbon cells, Lead storage and lithium batteries. Fuel Cells, Electro-deposition, Electrical and chemical requirements. Electroplating bath and linings. Agitation, Circulation and filtration equipment. Plating of copper, gold and rhodium.

UNIT V

Phase Equilibrium: Definitions of Phase, component and degree of freedom, Gibb's phase rule. One component systems: Water and sulphur. Two component systems: Pb-Ag and Cu-Ni system.

Univ VI

Green Chemistry: Introduction, Goals & Significance of Green Chemistry. Reagents, solvents and catalysts for green synthesis. Principles of Green Chemistry, Evaluation of feedstocks, reaction types and methods. Future trends in Green Chemistry.

Text Books/Reference Books:

1. "Thermal Analysis" by T. Hatakeyama, F.X. Quinn; Wiley.
2. " Inorganic Quantitative Analysis" by A.I. Vogel.
3. "Instrumental Method of Analysis" by Skoog D.A.; HRW International.
4. "Green Chemistry: Theory & Practice" by P.T. Anastas & JC Warner; Oxford Univ Press.
5. "Polymer Science and Technology" by Billmeyer; John Wiley.
6. "Polymer Science and Technology" by Fried; Prentice Hall.

EE – 105 Electrical Science	L T P	Credits
	3 1 0	4

UNIT I

Introduction: Role and importance of circuits in Engineering, concept of fields, charge, current, voltage, energy and there interrelationship. V-I characteristics of ideal voltage and ideal current sources, various types of controlled sources. Passive circuit components: V-I characteristics and ratings of different types of R, L, C elements. Series and parallel circuits, power and energy, Kirchoff's Laws. Delta-star conversion, Superposition Theorem, Thevenin's Theorem,

Norton's theorem, Maximum Power Transfer Theorem, Tellgen Theorem.

UNIT II

Single Phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, complex representation of impedance, series and parallel circuits, concept of phasor, phasor diagram, power factor, power in complex notation, real power, reactive power and apparent power. Resonance in series and parallel circuits, Q-factor, bandwidth and their relationship, half power points.

UNIT III

Three-Phase AC Circuits: Three phase EMF generation, delta and Y connection, line and phase quantities. Solution of three phase circuits: balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits.

UNIT IV

Magnetic Circuits & Transformers: Amperes circuital law, B-H curve, concept of reluctance, flux, MMF, analogies between electrical and magnetic quantities solution of magnetic circuits. Hysteresis and eddy current losses, application of magnetic force, mutual inductance and dot convention. Single phase Transformer construction, principle of working, auto transformer and their applications.

UNIT V

Measuring Instruments : Analog indicating instruments, devices, Damping devices, PMMC ammeters and voltmeters, shunt and multipliers, Moving iron ammeter and voltmeters, dynamometer type wattmeters, multimeters, AC watt-hour meters. Digital voltmeters, ammeters and wattmeters.

Text Books/Reference Books:

1. "Basic electrical Engineering" by C.L. Wadhwa, 4th Edition; New Age International.
2. "Basic Electrical Engineering" by Fitzereld, Higgenbotham & Grabel; McGraw Hill International.
3. "Electrical Engineering Fundamentals" by Vincent Deltoro; Prentice Hall International (EEI).
4. Relevant Indian Electricity Supply rules & BIS codes.

IT – 106 Fundamentals of Information Technology	L T P	Credits
	2 1 0	3

UNIT I

Fundamental Concepts of Information: Definition of information, Data Vs Information, Introduction to Information representation in Digital Media, Text, image, graphics, Animation, Audio, Video etc., Need, Value and Quality of information

UNIT II

Concepts in Computer & Programming: Definition of Electronic Computer, History, Generations, Characteristic and Application of Computers, Classification of Computers, Memory, different types of memory, Computer Hardware-CPU, Various I/O devices, Peripherals, Firmware and Humanware.

UNIT III

Programming Language Classification & Program Methodology: Computer Languages, Generation of Languages, Translators, Interpreters, Compilers, Flow Charts, Dataflow Diagram, Assemblers, Introduction to 4GL and 5GL.

UNIT IV

Digital Devices and Basic Network Concepts: Digital Fundamentals: Various codes, decimal, binary, hexa-decimal conversion, floating numbers gates, flip flops, adder, multiplexes, Introduction to Data Transmission.

UNIT V

Data Communication & Networks: Computer Networks-Introduction of LAN, MAN and WAN. Network Topologies, Client-server Architecture.

UNIT VI

Internet and Web Technologies: Hypertext Markup Language, DHTML, WWW, HTTP, Gopher, FTP, Telnet, Web Browsers, Net Surfing, Search Engines, Email, Safety of Business Transaction on web. Elementary Concepts of E-Learning and E-Commerce, Electronic Payment Systems, Digital Signatures, Firewall.

Text Books/Reference Books:

1. "Using Information Technology: A Practical Introduction to Computers & Communications" by William Sawyer & Hutchinson; Publisher: Tata McGraw-Hill.
2. 'Introduction to Computers' by Peter Norton; Tata McGraw-Hill.
3. "Introduction to Computers" by Rajaraman; EPI.
4. "Data Compression" by Nelson; BPB.
5. "Internet, An introduction"by CIS Tems; Tata McGraw Hill.
6. "Information Technology: Breaking News" by Curtin; TMH.
7. "Fundamentals of Information Technology" by Leon & Leon; Vikas.
8. "Internet 101" by Lehngart; Addison Wesley.

AP-107 Applied Physics - I Lab	L T P	Credits
	0 0 2	02

AC-108 Applied Chemistry Lab	L T P	Credits
	0 0 2	02

EE-109 Electrical Science Lab	L T P	Credits
	0 0 2	02

IT-110 Fundamental of IT Lab	L T P	Credits
	0 0 2	02

AM- 111 Mathematics-II	L T P	Credits
	3 1 0	4

UNIT I

Matrices: Rank of a matrix, inverse of a matrix using elementary transformations, consistency of linear system of equations, Eigen-values and eigenvectors of a matrix, Cayley-Hamilton theorem, diagonalization of matrix.

UNIT II

Ordinary Differential Equations: Second & higher order linear differential equations with constant coefficients, General solution of homogenous and non- homogenous equations, method of variation of parameters, Euler-Cauchy equation, simultaneous linear equations.

UNIT III

Special Functions : Power series method, Frobenious method, Legendre equation, Legendre polynomials, Bessel equation, Bessel function of fist kind, Orthogonal Property, Rodrigues' Formula.

UNIT IV

Laplace Transforms: Basic properties, Laplace transform of derivatives and integrals, Inverse Laplace transform, Differentiation and Integration of Laplace transform, Convolution theorem, UNIT of Step Function, Periodic function, Laplace transform to IVP and boundary value problem Applications system of linear Simultaneous differential equations.

UNIT V

Fourier series: Fourier series, Dirichlet conditions, Even and odd functions, half range series, harmonic analysis.

UNIT VI

Fourier Transforms : Fourier Transforms Sine and Cosine Transforms, Transforms of derivatives and integrals, Applications to boundary value problem in ordinary differential equations (simple cases only).

Text Books/Reference Books:

1. "Advanced Engineering Mathematics" by Greenberg; Pearson Education.
2. "Advanced Engineering Mathematics" by Kreyszig; Wiley.
3. "Advanced Engineering Mathematics" by Taneja; I K international.
4. "Advanced Engineering Mathematics" by Jain/Iyenger; Narosa.

EN – 112 Environmental Science	L T P	Credits
	2 0 0	2

UNIT I

Introduction to Environment: Origin & evolution of earth, segments of environment- lithosphere, hydrosphere, atmosphere & biosphere, Biogeochemical cycles- hydrological, oxygen, nitrogen, carbon & phosphate cycles.

UNIT II

Ecosystems: Concept of ecosystem biotic & abiotic components, types of ecosystems, functional components of ecosystem- biodiversity, productivity, food chains & food webs, material cycling and energy flow, different ecosystems- forest, grassland, desert, aquatic.

UNIT III

Water Pollution: Water quality, physical, chemical & biological characteristics of water & waste water, ground water pollution, water borne diseases.

UNIT IV

Air & Noise Pollution: Primary & secondary air pollutants, sources, effects & control of- carbon monoxide, nitrogen oxides, hydrocarbons, sulphur dioxide & particulates, Air quality standards, global warming, acid rain, El Nino, ozone hole. Classification and measurement of noise, effects of noise pollution on human, control of noise pollution.

UNIT V

Energy & Solid Waste Management: Conventional energy resources- coal, thermal, petroleum, hydroelectricity, nuclear power, wood, non conventional sources- solar, biogas, wind, ocean & tidal energy, geothermal energy. Hazardous and non hazardous solid waste management. Environmental laws and acts.

Text Books/Reference Books:

1. "Environmental Studies" by De Anil Kumar & De Arnab Kumar; New Age International (P) Ltd.
2. "Environmental Studies" by Basak Anindita; Pearson Education South Asia.
3. "A Text Book of Environmental Science" by Subramanian. V; Narosa Publishing House.
4. "Essentials of Ecology & Environment Science" by Rana. S.V.S.; EPI Publications.

AP – 113 Applied Physics - II	L T P	Credits
	4 0 0	4

UNIT I

Quantum Physics : Failure of classical physics ,Compton effect , Pair production de-broglie relation, wave function, Probability density, Schrodinger wave equation, operators, expectation values and eigen-value equation, particle in a box, simple harmonic oscillator problem, concept of degeneracy.

UNIT II

Classical Statistics : Statistical physics : Microscopic-macroscopic systems, concept of phase space, basic postulates of statistical mechanics, Maxwell—Boltzmann distribution law.

UNIT III

Quantum statistics : Quantum Statistics : Fermi—Dirac and Bose –Einstein Distribution, Fermi- Dirac probability function, Fermi energy level.

UNIT IV

Nuclear Physics : Nuclear properties, constituent of the nucleus, binding energy, stable nuclei, radioactive decay law (alpha and beta spectrum), Q-value of nuclear reaction , nuclear models-liquid drop and shell model, nuclear fission and fusion, elementary ideas of nuclear reactors.

UNIT V

Electrodynamics : Maxwell's equations, concept of displacement current, Derivation of wave equation for plane electromagnetic wave, Poynting vector. Poynting theorem, Energy density, wave equation in dielectric & conducting media.

Text Books/Reference Books:

1. "Nuclear Physics" by Erwin Kaplan.
2. "Concept of Nuclear Physics" by Cohen.
3. "Electrodynamics" by Griffith.
4. "Electricity & magnetism" by Rangawala & Mahajan.
5. "Perspective of Modern Physics" by Arthur Beiser.

AP-AC 114 Engineering Materials	L T P	Credits
	4 0 0	4

SECTION – A (PHYSICS)

UNIT I

Crystal Structure: Bravais lattices; Miller indices, simple crystal structures, Different kind of bonding.

UNIT II

Metallic Conduction: Energy distribution of electrons in a metal, Fermi level, Conduction process.

Semi Conductors: Band theory of solids , P and N type of semiconductors , Statistics of holes and electrons, Hall effect , Effect of temperature on conductivity , Life time and recombination, drift and diffusion in PN junction .

UNIT III

Dielectric and Optical properties of Materials: Dielectric polarization and dielectric constant, optical absorption process.

Magnetism and Superconducting Materials: Diapara, Ferro-magnetism, Antiferro, Ferro-magnetism ferrites, Superconducting materials, Properties, Type of superconducting materials , Meissner effect, High- Tc superconductor, application.

SECTION – B (CHEMISTRY)

UNIT IV

Introduction to engineering materials for mechanical construction. Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

UNIT V

Composite materials: Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fiber-reinforced composites, environmental effects on composites, applications of composites.

UNIT VI

Speciality Polymers: Conducting polymers-Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory Introduction, classification, properties, raw materials, manufacturing and applications.

NOTE: Two hrs per week load for Applied Physics Department.

Two hrs per week load for Applied Chemistry Department.

Text Books/Reference Books (PHYSICS):

1. "Solid State Physics", 7th edition by Kittel; J. W .& Sons Publication.
2. "Solid State Physics" by Wahab M.A.; Narosa Publishing House.
3. "Solid State Physics" by Ali OmerM; Pearson Education (Singapore) pvt. Ltd. India branch, New delhi.
4. "Engineering Materials: Properties and Selection", 7th edition by Kenneth G. Budinski, Budinshi; Pearson Singapor (Prentice Hall).
5. "Solid State Physics" by Pillai S.O.; New Age International Publication.

Text Books/Reference Books (CHEMISTRY)

1. "Essentials of Material Science and Engineering " by Donald R. Askeland, Pradeep P. Phule; Thomson.
2. "Speciality Polymers " by R.W.Dyson; Chapman and Hall, New York, USA.
3. "Polymer Composites " by A.P.Gupta, M.C.Gupta; New Age publication.
4. "Engineering Chemistry " by R.N.Goyal, H.Goel; Ane Books India.
5. "Engineering Chemistry" by S.S.Dara; S.Chand.
6. "Engineering Chemistry" by Raghupati Mukhopadhyay, Sriparna Datta; New Age International.
7. "Engineering Chemistry" by P.C.Jain, Monica Jain; Dhanpat Rai.

ME 115 Basic Mechanical Engineering	L T P	Credits
	4 0 0	4

(PART A)

UNIT I

Introduction to Thermodynamics, Concepts of systems, control volume, state, properties, equilibrium, quasi-static process, reversible & irreversible process, cyclic process. Zeroth Law and Temperature, Ideal Gas. Heat and Work.

UNIT II

First Law of Thermodynamics for closed & open systems. Non Flow Energy Equation. Steady State, Steady Flow Energy Equation.

Second Law of Thermodynamics – Kelvin and Planck's Statements, Clausius inequality, Definition of Heat Engine, Heat pump, Refrigerator. Concept of Entropy and availability. Carnot Cycle; Carnot efficiency, Otto, Diedel, Dual cycle and their efficiencies.

UNIT III

Properties & Classification of Fluids, Ideal & real fluids, Newton's law of viscosity, Pressure at a point, Pascal's law, Pressure variation in a static fluid, Introduction to Bio-fluid Mechanics General description of fluid motion, stream lines, continuity equation, Bernoulli's equation, Steady and unsteady flow. Turbines and pumps.

(PART-B)

UNIT IV

Introduction to Manufacturing processes for various machine elements. Introduction to Casting & Welding processes. Fabrication of large & small components and assemblies- example Nuts and Bolts, Water turbine rotors, Large Electric Generators, introduction to turning, milling, shaping, drilling & boring processes.

UNIT V

Introduction to quality measurement for manufacturing processes; standards of measurements, line standards and, end standards, precision measuring instruments and gauges: vernier calipers, height gauges, micrometers, comparators, dial indicators, and limit gauges.

Text Books/Reference Books

1. "Engineering Thermodynamics" by P. K. Nag.
2. "Fundamentals of Classical Thermodynamics" by G. J. Van Wyle and R. E. Santag.
3. "Introduction to Fluid Mechanics and Fluid Machines" by S. K. Som and G. Biswas.
4. "Fluid Mechanics" by V. L. Streeter and E. B. Wylie.
5. "Fluid Mechanics and Hydraulic Machines" by R. K. Bansal.
6. "Manufacturing Processes" by Kalpakjian.
7. "Workshop Practics" by A. K. Hazara Chowdhary.
8. "Workshop Technology" by W. A. J. Chapman.
9. "Production Engineering" by P.C. Sharma.
10. "Production Engineering" by R. K. Jain.

COE– 116 Programming Fundamentals	L T P	Credits
	2 0 0	2

UNIT I

Introduction: Concepts of algorithm, flow chart, Introduction to different Programming Languages like C, C++, Java etc.

Elementary Programming: Data types, assignment statements, conditional statements and input/output statements. Iterative programs using loops.Concept of subprograms. Coding style: choice of names, indentation, documentation, etc.

UNIT II

Arrays: Array representation, Operations on array elements, using arrays, multidimensional arrays.

Structures & Unions: Declaration and usage of structures and Unions.

Pointers: Pointer and address arithmetic, pointer operations and declarations, using pointers as function argument.

File: Declaration of files, different types of files. File input/ output and usage.

UNIT III

Object Oriented Programming: Functional and data decomposition, Characteristics of Object-Oriented Languages: Abstraction, Encapsulation, Information hiding, abstract data types,

Classes and Objects: Concept of Object & classes, attributes, methods, C++ class declaration, private and public memberships, Constructors and destructors, instantiation of objects. Introduction to Class inheritance and operator overloading.

UNIT IV

Files: Streams and files, error handling, over view of Standard Template Library.

Text Books/Reference Books :

1. "Problem Solving and Program Design in C" by Jeri R. Hanly, Elliot B. Koffman; Pearson Addison-Wesley, 2006.
2. "A Structured Programming Approach Using C" by Behrouz A.Forouzan, Richard F. Gilberg; Thomson Computer Science- Third Edition [India Edition], 2007.
3. "C++: The Complete Reference" by Schildt Herbert; Wiley DreamTech, 2005.
4. "Object Oriented Programming using C++" E. Balagurusamy, TMH. R. Lafore; BPB Publications, 2004.
5. "Object Oriented Programming with C++" by D . Parasons; BPB Publication, 1999.
6. "The Art of Programming Computer Science with C++" Steven C. Lawlor; Vikas Publication, 2002.

AP 117 Applied Physics - II Lab	L T P	Credits
Laboratory Practical Based on course work corresponding AP113	0 0 2	2

COE 118 Programming Lab	L T P	Credits
Laboratory Practical Based on course work corresponding COE-116	0 0 2	2

ME– 119 Engineering Graphics	L T P	Credits
	0 0 3	3

General: Importance, Significance and scope of engineering drawing Lettering, Dimensioning, Scales, Sense of Proportioning, Different types of Projections, B.I.S. Specification, line symbols, rules of printing.

Projections of Points and Lines: Introduction of planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance, intersecting and non-intersecting lines.

Planes Other than the Reference Planes: Introduction of other planes (perpendicular and oblique), their traces, inclinations etc., projections of points lines in the planes, conversion of oblique plane into auxiliary plane and solution of related problems.

Projections of Plane Figures: Different cases of plane figure (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

Projection of Solids: Simple cases when solid is placed in different positions, Axis, faces and lines lying in the faces of the solid making given angles.

Isometric and Orthographic: First and Third angle of system of projection sketching of Orthographic views from pictorial views and vice –versa principles and type of sectioning. Development of Surface

Text Books/Reference Books

1. "Engineering Graphics" by Narayana, K.L. and Kannaiah, P.; Tata McGraw Hill, New Delhi
2. "Elementary Engineering Drawing" by Bhatt N.D.; Charotar Book Stall, Anand
3. "Engineering Graphics" by Lakshminarayaan, V. and Vaish Wanar, R.S.; Jain Brothers, New Delhi
4. "Engineering Graphics" by Chandra, A.M. and Chandra Satish; Narosa

PE 120 Mechanical Workshop	L T P	Credits
	0 0 3	3

Fitting shops, Welding shops, Foundry Shops, Sheet Metal Shop, Smithy Shop.

EE-201 Electronic Devices & Circuits	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Electronics : Signals, frequency spectrum of signals, analog and digital signals, amplifiers, circuit models of amplifiers, frequency response, digital logic inverters. Diodes; Ideal diodes, physical operation and terminal characteristics, small signal models, operation in reverse breakdown region, Zener diode, rectifier circuits, limiting and clamping circuits etc.

UNIT II

Bipolar Junction Transistors: Physical structure and modes of operation, symbols, operation in active mode, graphical representation of transistor characteristics, DC analysis of transistor circuits, transistor as an amplifier and small signal model, transistor biasing, CE, CC and CB amplifier configurations, transistor as switch, large signal model of the transistor.

UNIT III

MOSFETs and Field Effect Transistors: Structure and physical operation of enhancement type MOSFET, current-voltage characteristics, depletion type MOSFET, MOSFET as an amplifier, basic single stage MOSFET amplifiers, all NMOS amplifier stages, JFETs, etc. Differential and Multistage Amplifiers: BJT differential pair, small signal model and operation, differential amplifiers with active loads, MOS differential amplifiers, multistage amplifiers, etc.

UNIT IV

Frequency Response : Low frequency response of CE and CS amplifier, high frequency response of CS and CE amplifier, CB, CC and cascade configurations and their frequency response, frequency response of CC-CE cascade.

UNIT V

Feedback amplifiers and Oscillators : Principles of feed back in amplifiers, advantages of negative feedback, effect of feedback on impedances, Nyquist criterion for stability, Barkhausen criterion for sinusoidal oscillators, phase shift oscillator, Wien-bridge oscillator, resonant circuit oscillators, crystal oscillators, frequency stability.

Text Books/Reference Books :

1. Microelectronic Circuits, Sedra A. S. and Smith K. C, Oxford university Press, 5th Edition
2. Electronic Devices & Circuit Theory Robert L Boylestad Louis Nashelsky, PHI
3. Electronic Devices and Circuits,Jacob. Millman, Christos C.Halkias, Tata McGraw Hill Publishing Limited, New Delhi, 2003.
4. Electronic Devices and Circuits, David A.Bell, Prentice Hall of India Private Limited, New Delhi, 2003.

EE -202 Electrical Machines- I	L T P	Credits
	3 1 0	4

UNIT I

Transformers : General constructional features, type of transformers, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, concepts of coupled circuits, voltage, current and impedance relationships, equivalent circuits and phasor diagrams at no load and full load conditions, voltage regulation, losses and efficiency, all day efficiency, auto transformer and equivalent circuit, comparison of copper volume with two winding transformer, practical determination of equivalent circuit parameters and phasor diagrams, parallel operation and load sharing with equal and unequal voltage ratios, advantages of per unit system.

UNIT II

Poly Phase Transformers : Poly phase connections, star-star, star-delta, delta-star and delta-delta connections, use of delta connection for third harmonics, zig-zag connection, tertiary windings, vector groups with clock convention, phase conversions- 3-phase to 1 phase, 3-phase to 6-phase, 3-phase to 2-phase (Scott connection) and 3 phase to 12 phase, Special Purpose transformers; instrument transformers and high frequency transformers.

UNIT III

Electromechanical Energy Conversion Principles: Forces and torques in magnetic field systems, single and multiple excited magnetic field systems, forces and torques in systems with permanent magnets, generated emf in electrical machines with concentrated & distributed windings.

UNIT IV

D.C. Machines : Basic constructional features of DC machines, separately and self excited machines, armature winding details - lap & wave connections, DC generators; emf equation, armature-reaction, commutation, characteristics of different types of DC generators. DC motors; torque equation, armature-reaction, commutation, interpoles, compensating windings, characteristics of different types of D.C. motors. DC motor starting methods and types of starters, speed control, losses, efficiency and testing; Dynamics of DC motors.

Text Books/Reference Books :

1. Electric Machinery, Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, Tata McGraw Hill, 2006.
2. Electromechanical Energy Conversion with Dynamics of machines, R.D. Begamudre, New Age International publishers, New Delhi, 1998.
3. Performance and Design of DC Machines, Clayton and Hancock, BPB Publications, Hyderabad.
4. Performance and Design of Alternating Current Machines, M.G. Say, CBS Publishers, New Delhi, 2008.
5. Electric Machines, Nagrath I. J and Kothari D.P. Tata McGraw Hill Publishing Company Ltd, 2010.
6. Problems in Electrical Engineering, Parker Smith, CBS Publishers, New Delhi.

EE 203 Network Analysis And Synthesis	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Introduction to continuous and discrete signals, their classification and types, periodic waveforms and signal synthesis, Fourier representation of continuous time periodic and aperiodic signals, LTI systems and their properties; system modeling in terms of differential equations and transient response of R, L, C circuits for impulse, step, ramp, sinusoidal and exponential signals.

UNIT II

Network Topology and Graph Theory : Introductory concepts of network graphs, cut sets, loops, cut set and loop analysis.

UNIT III

Network Theorems : Superposition, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, reciprocity theorem, Miller's theorem.

UNIT IV

Laplace Transform: Review of properties and applications of Laplace transform of complex waveform and transient response of R- L- C series, parallel, series-parallel circuits for all kinds of excitations.

UNIT V

Two Port Networks and Elements of Realizability : z, y, h, g, ABCD, inverse ABCD parameters, their inter conversion, interconnection of two 2-port networks, concept of transform impedance. Positive real functions; definition & properties, Foster's I and II, Cauer's I and II forms, Synthesis of LC, RC, RL Networks, image parameters and basics of two-port synthesis.

Text Books/Reference Books :

1. Network Analysis, M.E. Van Valkenburg, M.E., PHI, 2000.
2. Linear circuit Analysis: Time Domain, Phasor, and Laplace Transform Approaches, Decarlo & Lin, Oxford, 2001.
3. Network Analysis and Synthesis, F.F. Kuo, John Wiley and Sons, 2nd Edition.
4. Engineering Circuit Analysis, Hayt, Kemmerly & Durbin, Tata McGraw Hill Publishing Company Ltd, 2007.
5. Basic Circuit Theory, Desoer and Kuh, McGraw Hill International Student Edition.

EE-204 Power Plant Engineering	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Thermodynamic equilibrium, cyclic process,

enthalpy, zero, first and second laws of thermodynamics, Carnot cycle, concept of entropy, properties of steam, processes involving steam in closed and open systems, enthalpy. Vapour pressure cycles: Rankine cycle, reheat cycle, regenerative cycle

UNIT II

Steam Turbine : Classification, impulse and reaction turbines their velocity diagrams and related calculations, work done and efficiencies, re-heat factor, staging, bleeding and governing of turbines. Gas Turbine: Classification, Brayton cycle, working principle of gas turbine, gas turbine cycle with intercooling, reheat and regeneration, stage and polytrophic efficiencies.

UNIT III

Compressors : Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling. I.C. Engines: Otto, Diesel and dual cycles, introduction to 2-stroke and 4-stroke SI and CI engines, indicator diagram and power measurement.

UNIT IV

Impact of Jet : Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve), effect of inclination of jet with the surface. Hydraulic Turbines: Classification, heads and efficiencies, construction, working, work done and efficiency of impulse and reaction turbines.

UNIT V

Centrifugal Pump : Classification, construction, working, work-done, efficiencies, cavitations and priming, jet pump. Reciprocating Pump: classification, construction, working, work-done, slip and coefficient of discharge.

Text Books/Reference Books :

1. Applied Thermodynamics, Onkar Singh, New Age International, 2006.
2. A Text Book of Hydraulic Machines, R.K.Rajput, S. Chand & Co., 2008.
3. Thermal Engineering, P.L. Ballany, Khanna Publishers, 2003.
4. A Text Book of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, Laxmi Publications, 2006.
5. Power Plant Engineering, Gautam S, Vikas Publishing House, 2012.

EE-205 Electrical And Electronic Measurements	L T P	Credits
	3 1 0	4

UNIT I

Electrical Measurements : Standards of measurements, errors and their statistical evaluation, parasitic effects of circuit components. Calibration: accuracy, precision, sensitivity, resolution, noise.

UNIT II

Measurement of Circuit Components : Measurement of low, medium, high resistance, insulation resistance measurement, measurement of earth resistance. AC & DC Potentiometers, generalized theory of AC bridges, Wien's bridge, Schering's bridge, measurements of dielectric loss, universal bridge, self balancing bridges, transformer ratio bridges and screening, multiple earth and earth loop, electrostatic and electromagnetic interference, grounding techniques, vibration galvanometer and null detecting devices.

UNIT III

Magnetic Measurement : Determination of B-H curve, measurement of iron losses, analog and digital instruments for measurement of frequency and phase.

UNIT IV

Measuring Devices and Systems : Theory and design of D' Arsonval galvnometer, concept of multi range meters, dynamometer type wattmeter, and Induction type energy meter.

UNIT V

Electronic Measuring Devices : CRO and its applications, active and passive probes, current probes, storage oscilloscope, Multimeter, Digital Voltmeter, Electronic energy meter & Electronic Wattmeter

Text Books/Reference Books :

1. Measurement Systems – Application and Design, E.O. Doeblin, Tata McGraw Hill, 2003.
2. A Course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai and Co, 2004.
3. Digital Instrumentation, A.J. Bouwens, Tata McGraw Hill, 1997.
4. Transducers and Instrumentation, D.V.S. Moorthy, Prentice Hall of India Pvt. Ltd, 2003.
5. Electronic Instrumentation, H.S. Kalsi, Tata McGraw Hill, 1995.
6. Electrical Measurements, Martin Reissland, New Age International (P) Ltd., Delhi, 2001.
7. A Course in Electronic and Electrical Measurements, J.B. Gupta, S.K. Kataria & Sons, Delhi, 2003.

EE -206 Engineering Economics	L T P	Credits
	3 0 0	3

UNIT I

Applied Economics : Economics – introduction, law of demand and supply, elasticity of demand and supply: price, cross income, advertisement, production function and factor of production, type of market, money and bank, credit creation by bank, tax and subsidy, monetary policy and fiscal policy.

UNIT II

Modern Theory of International Trade : Forecasting and decision analysis, problems of Indian economy and how engineers can help in their alleviation. How introduction of information technology has affected different sector: production, marketing, customer interaction

UNIT III

Management : Introduction, history of management, difference and relationship between management, administration and organization, engineering manager, management obligation and ethical considerations

UNIT IV

Financial Management : Concepts, purpose of investment, type of capital, sources of finance, financial accountancy, book keeping, the journal and ledger, balance sheet, financial ratios.

Text Books/Reference Books :

1. Applied Economics: Thinking Beyond stage One, Thomas Sowell, Basic Books, 2nd Edition, 2007.
2. Microeconomics: Principles and Policy, William J. Baumol and Alan S. Blinder, Cengage Learning, 12th Edition, 2011.
3. Management Process and Organizational Behavior, Karam Pal, I.K. International Publishing House, Delhi, 2007.
4. Management, R. Gulati, A.J. Mayo and N. Nohria, Cengage Learning, 1st Edition, 2013.
5. Fundamentals of Management Concepts Functions Role and Profile, S.S. Kharka, S. Chand & Company Ltd, New Delhi,2001.
6. Economics for Engineering Students, Seema Singh, I.K. International Publishing House, Delhi, 2009.

EE-207 Electronics Devices and Circuits lab	L T P	Credits
	0 0 2	2

Based on course work corresponding EE-201

EE-208 Electrical and Electronic Measurement Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding EE-205

EE-209 Electrical Machines - I Lab	L T P	Credits
	0 0 2	2

Based on the course work corresponding to EE-202

EE-210 Term Paper - I	L T P	Credits
	0 0 1	1

EE 211 Linear Integrated Circuits	L T P	Credits
	3 1 0	4

UNIT I

Feedback Amplifiers : General feedback structure, properties of negative feedback, basic feedback topologies, determination of loop-gain, stability problem

UNIT II

IC OP-AMP Applications : OP-AMP fundamentals (Brief review of differential amplifier, current mirror, active load, level shifter, output stage; ac and dc characteristics), basic building blocks using OP-AMPS, inverting/non inverting VCVS, integrators, differentiators, CCVS, Instrumentation amplifiers, Biquad filter (LP, HP, BP and notch), Oscillators, A/ D & D/A convertors

UNIT III

Non-linearAmplifiers : Logarithmic amplifiers, Log/antilog modules, Precision rectifier, Peak detector, Sample and Hold circuits

UNIT IV

Comparators and Timers : OP-AMP as comparator, Schmitt Trigger, Square and Triangular wave generator, mono stable and astable multi vibrator, IC timers and their applications. IC Analog multipliers: Basic circuits, applications

UNIT V

IC OTA Applications : Basic building blocks using OTA, electronically programmable functional circuit examples. Voltage regulators: (78/79, XX), 723 IC regulators (current limiting, current fold back), SMPS. Applications of analog switches: programmable gain amplifiers

Text Books/Reference Books :

1. Microelectronic Circuits, A. S. Sedra and K.C. Smith, Oxford University Press, 5th Edition, 2003.
2. Microelectronic Circuits: Analysis and Design, M.H. Rashid, Oxford University Press, 5th Edition, 2003.
3. Applications and Design with Analog Integrated Circuits, M. Jacob, PHI/Dorlin Kindersley.
4. Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, TMH.

EE-212 Control System-I	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Linear, non linear, time varying and linear time invariant system, servomechanism, historical development of automatic control and introduction to digital computer control, mathematical models of physical systems, differential equations of physical systems, transfer functions, block diagram algebra and signal flow graphs.

UNIT II

Feed Back Characteristics of Control Systems : Feedback and non-feedback systems, advantages and disadvantages of negative feedback, regenerative feedback. Control Systems

and Components: DC and AC servomotors, synchros, tacho generator and stepper motors, ADC and DAC etc.

UNIT III

Time Response Analysis, Design Specifications and Performance Indices : Standard test signals, time response of first-order systems, time response of second-order systems, steady-state error and error constants, effect of adding a zero to a system, P, PI and PID control actions and their effect, design specifications of second-order systems and performance indices.

UNIT IV

Concepts of Stability and Algebraic Criteria : The concept of stability, necessary and sufficient conditions for stability, Routh's stability criterion and relative stability analysis. Root locus technique: root locus concept, construction of root loci, root contours, systems with transportation lag, sensitivity of the roots of the characteristic equation, analysis and design of control systems with MATLAB

UNIT V

Frequency Response Analysis : Correlation between time and frequency response, polar plots, Bode plots, and all pass and minimum-phase systems. Stability in frequency domain: mathematical preliminaries, Nyquist stability criterion, definition of gain margin and phase margin, assessment of relative stability using Nyquist and Bode Plots, constant M-circles, constant N-circles, Nicholas chart, closed-loop frequency response.

Text Books/Reference Books :

1. Automatic Control Systems, Kuo, B. C. Prentice Hall of India.
2. Modern Control Engineering, Ogata. K Prentice Hall of India
3. Linear Control Systems, James Melsa, Donald Schultz, Mcgraw-Hill,1992.
4. Control Systems Engineering, Norman S. Nise, John Wiley and Sons, 2011.
5. Control Systems Engineering, Nagrath I. J. and Gopal M., New Age International. Publishers

EE-213 Digital Circuits and Systems	L T P	Credits
	3 1 0	4

UNITI

Review of number system : Types and conversion, codes, Boolean algebra, De-Morgan's Theorem, switching functions and simplification using K-maps and Quine McCluskey method.

UNIT II

Design of Logic Gates : Comparators, code converters, encoders, decoders, multiplexers and de-multiplexers, function realization using gates, multiplexers.

UNIT III

Design and Analysis of Combinational Logic Circuits Adders, subtractors, code converters, multilevel NAND and NOR logic circuits.

UNIT IV

MSI and LSI Combinational Logic Circuits : Decimal adder, decoders, digital system design with multiplexers, ROM, PROM, EPROM, PLA.

UNIT V

Flip Flops and Counters : Types of flip flops, analysis and design of clocked sequential circuits, counters, state diagram, state reduction, state assignment.

UNIT VI

Logic Families : DTL, TTL, ECL, I2L, MOS and CMOS logic families.

Text Books/Reference Books :

1. Digital Logic and Computer Design, M. Morris Mano, Prentice Hall of India,2002.
2. Digital Logic: Applications and Design, John M. Yarbrough, CL Engineering,1996.
3. Fundamentals of Logic Design, Jr. Charles H. Roth and Larry L Kinney, Cengage Learning,2013.
4. Digital Fundamentals, Thomas L. Floyd, Prentice Hall, 10th edition, 2008.
5. Digital Design: Principles and Practices John F. Wakerly, Prentice Hall, 4th edition, 2005.
6. Fundamentals of Digital Circuits, Anand Kumar, Prentice Hall of India, 2006.

EE-214 Power System -I	L T P	Credits
	3 1 0	4

UNIT I

Power System Components : Single line diagram of power system, brief description of power system elements, synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator. Supply System: different kinds of supply system and their comparison, choice of transmission voltage. Transmission Lines: configurations, types of conductors, resistance of line, skin effect, Kelvin's law. proximity effect.

UNIT II

Over Head Transmission Lines : Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit ,transmission lines, representation and performance of short, medium and long transmission lines, Ferranti effect, surge impedance loading.

UNIT III

Corona and Interference : Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and

interference, electrostatic and electromagnetic interference with communication lines. Overhead line Insulators: type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, string efficiency.

UNIT IV

Mechanical Design of transmission line : Catenary curve, calculation of sag & tension, effects of wind and ice loading, sag template, vibration dampers. Insulated cables: type of cables and their construction, dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of cables

UNIT V

Distribution systems : Basic idea of distribution systems, different types of loads, voltage drop in distributors, radial and ring main type of distribution systems.

Text Books/Reference Books :

1. Power System Analysis, J. Grainger and W. D. Stevenson, TMH, 2006.
2. Power System Analysis, A.R. Bergen and V. Vittal, Pearson, 2008.
3. Power System Control and Stability, P. Kundur, TMH, 2006.
4. Electrical Power Systems, C. L. Wadhwa, New age international Ltd. Third Edition
5. Power System, Asfaq Hussain, CBS Publishers and Distributors, 2000.
6. Electrical Power System Design M. V. Deshpande, Tata Mc Graw Hill,1985.
7. Elements of Electrical Power Station Design, M.V. Deshpande, PHI Learning, 2009
8. A Course in Electrical Power, Soni, Gupta, Bhatnagar, Dhanpat Rai & Sons.
9. Electric Power, S.L.Uppal, Khanna Publishers.
10 Electric Power Generation, Transmission & Distribution, S.N.Singh, PHI Learning.

EE-215 Electrical Machines-II	L T P	Credits
	3 1 0	4

UNIT I

Asynchronous Machines -I : General constructional features of poly phase asynchronous motors, concept of rotating magnetic field, principle of operation, phasor diagram, Equivalent circuit, torque and power equations, torque-slip characteristics, practical determination of equivalent circuit parameters, losses and efficiency.

UNIT II

Asynchronous Machines-II : Starting methods for asynchronous motors, role of deep bar and double cage rotor, DOL, autotransformer and star delta starters, speed control, V/f control, braking, and power factor control of asynchronous motors, time and space harmonics, effect of space and time harmonics on asynchronous machine performance, cogging and crawling. Operation of asynchronous machine as asynchronous generator-grid connected and self excited modes of operation. Dynamics of asynchronous machines,

UNIT III

Synchronous Machines -I : General constructional features, armature winding, emf equation, effect of distribution and pitch factor, flux and mmf relationship, phasor diagram, non-salient pole machine, equivalent circuit, determination of equivalent circuit parameters by open and short circuit tests, voltage regulation using synchronous impedance method, Potier's triangle method, power angle characteristics, parallel operation of synchronous generators, synchronizing power and torque coefficient, operation on infinite bus, effect of excitation control.

UNIT IV

Synchronous Machines -II : Operation as synchronous motor, phasor diagram, starting methods, V-curves, synchronous condenser, hunting and damping, salient-pole synchronous machine, two-reaction theory, phasor diagram, steady state equivalent circuit, practical determination of Xd and Xq by slip test, maximum lagging current method, power angle characteristics of synchronous machines, dynamics of synchronous machines.

Text Books/Reference Books :

1. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 2006.
2. M.G. Say, 'Performance and Design of Alternating Current Machines', CBS Publishers, New Delhi, 2008.
3. Philip Kemp, Alternating Current Electrical Engineering, Mc Millan, London.
4. Nagrath I. J and Kothari D.P. 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2010.
5. Parker Smith, Problems in Electrical Engineering, CBS Publishers, New Delhi.

EE-216 Electromagnetic Field Theory	L T P	Credits
	3 0 0	3

UNIT I

Mathematical Orientation : Review of gradient curl and divergence operations. Volume, surface and line integrals, vector identities, coordinate system and transformation of vectors in various coordinate systems, Dirac delta function.

UNIT II

Static Electric Fields : Coulomb force, field due to number of charges, charge density functions, Dirac delta representation of charges, fields due to various sources, scalar potential, method of evaluating fields, fields in dielectrics, polarization, D and P vectors, electric dipole and dipole moment, concept

of simple medium, boundary conditions, capacitors, energy stored in electric fields, solution of Laplace equation in various coordinate system by separation of variables, field mapping and conformal transformation, statement and interpretation of Maxwell's equations.

UNIT III

Steady Magnetic fields : Lorentz force equation, concept of magnetic intensity and magnetic field, Biot – Savart's Law, magnetic vector potential, force and torque between the current carrying conductors, loops, solenoid, magnetic material, magnetic dipole M vector, calculation of inductance for simple geometries, energy stored in a magnetic field, solution of magnetic static problems by separation of variables, field mapping and conformal transformation, magnetic circuits, statement and interpretation of Maxwell's equations.

UNIT IV

Time Dependent Fields : Generalization of Maxwell's equations in source free medium, plane waves and plane wave reflections at conductor and dielectric interfaces; wave propagation in conducting and dielectric media, concepts of surface impedance and skin effect, Poynting Vector and Poynting Theorem.

UNIT V

Guided Waves : Waves between parallel planes, transverse electric waves (TE), transverse magnetic waves (TM), characteristics of TE and TM waves, transverse electromagnetic wave, velocity of propagation, attenuation of wave in parallel planes.

Text Books/Reference Books :

1. Engineering Electromagnetics, William H. Hayt, Tata McGraw Hill, 2011.
2. Elements of Electromagnetics, Sadiku, 4th Edition, Oxford University Press, 2007.
3. Electromagnetics, John. D. Kraus, McGraw Hill , New York, 4th Edition, 1991.
4. Electromagnetics with Applications, Kraus and Flesish, McGraw Hill International, 5th Edition, 1999.
5. Introduction to Electrodynamics, David J. Griffiths, Addison-Wesley, 4th edition, 2012.
6. Elements of Engineering Electromagnetics, Nannapaneni Narayana Rao,6th Edition, Pearson Education, Inc, 2004.

EE-217 Linear integrated Circuits Lab	L T P	Credits
	0 0 2	2

Based on the course work corresponding to EE-211

EE-218 Power Systems- I Lab	L T P	Credits
	0 0 2	2

Based on the course work corresponding to EE-214.

EE-219 Electrical Machines- II Lab	L T P	Credits
	0 0 2	2

Based on the course work corresponding to EE-215.

EE-220 Term Paper -II	L T P	Credits
	0 0 1	1

EE – 301 Power Electronics	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Characteristics and switching behavior of Power Diode, SCR, UJT, TRIAC, DIAC, GTO, MOSFET, IGBT, MCT and power BJT, two-transistor analogy of SCR, firing circuits of SCR and TRIAC, SCR gate characteristics, SCR ratings. Protection of SCR against over current, over voltage, high dV/dt, high dI/dt, thermal protection methods of commutation, series and parallel operation of SCR.

UNIT II

AC to DC Converter : Classification of rectifiers, phase controlled rectifiers, single phase half wave controlled, fully controlled and half controlled rectifiers and their performance parameters, .three phase half wave, full wave and half controlled rectifiers and their performance parameters, effect of source impedance on the performance of single phase and three phase controlled rectifiers, single-phase and three phase dual converter.

UNIT III

D.C. to D.C. Converter : Classification of choppers, principle of operation, steady state analysis of class- A chopper, step up chopper, switching mode regulators, Buck, Boost, Buck-Boost, Cuk regulators, current commutated and voltage commutated chopper.

UNIT IV

A.C. to A.C. Converter : Classification, principle of operation of step up and step down cyclo-converter, single phase to single phase cyclo-converter with resistive and inductive load, three phase to single phase cyclo-converter, half wave and full wave, cosine wave crossing technique. three phase to three phase cyclo-converter. output voltage equation of cyclo-converter.

UNIT V

D.C. to A.C. Converter : Classification, basic series and improved series inverter, parallel inverter, single phase voltage source inverter, steady state analysis, half bridge and full bridge inverter, modified McMurray and modified Mc Murray Bedford inverter, voltage control in single phase inverters, PWM inverter, reduction of harmonics, current source inverter, three phase bridge inverter.

Text Books/Reference Books :

1. Power Electronic, Converters, Applications and Design, Ned Mohan, Tore M. Undeland and William P. Robbins, John Wiley & Sons
2. Power Electronics: Circuits, devices and applications, M.H. Rashid, PHI.
3. Fundamental of Power Electronics, Robert W. Erickson and Dragon Maksimovic, Springer International Edition, 2nd ed. 2001.
4. Modern Power Electronics, Evolution, Technology and Applications, Edited by B.K. Bose, Jaico Publishers
5. Power Electronics Principles and Applications, Joseph Vithayathil, Tata McGraw Hill Education, 2010
6. An Introduction to Thyristors and their applications, M. Ramamoorthy, East-West Press.

EE-302 Principles of Communication	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Electronic Communication Systems : Introduction, electronic communication system, types of communication system, frequency spectrum of EM waves, modulation, bandwidth and information capacity, transmission. Noise: internal noise (thermal, shot, transit time miscellaneous), external noise (atmospheric, industrial, extra terrestrial), noise calculations, noise figure, noise temperature.

UNIT II

Amplitude Modulation Systems : Transmission (principle, spectrum, efficiency, power and current calculation), AM envelop, AM modulator circuits, AM transmitters, QAM, AM receivers, receiver parameters (selectivity, sensitivity, dynamic range, fidelity), TRF receiver, super hetrodyne receiver, low noise amplifier, mixer/ converter, noise limiter, automatic gain control circuit.

UNIT III

Single Sideband Communication Systems : Single sideband system, AM SSB full carrier, AM SSB reduced carrier, AM SSB suppressed carrier, AM independent sideband, AM vestigial sideband, comparison of single sideband transmission to conventional AM, single sideband generation methods, single sideband transmitter.

UNIT IV

Angle Modulation system : Mathematical analysis, deviation sensitivity, waveforms, phase deviation and modulation index, frequency analysis of angle modulated system, bandwidth requirement of angle modulated system, noise and angle modulation, pre-emphasis and de-emphasis, generation of FM waves, demodulation of FM waves, angle modulation vs. amplitude modulation.

UNIT V

Pulse Modulation : Nyquist theorem, practical sampling, PAM, PWM and PPM generation and detection. Noise in CW modulation: noise calculation in communication system, noise in amplitude modulation system, noise in angle modulated system, narrow band noise.

Text Books/Reference Books :

1. Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University Press, 3rd Edition.
2. Principles of Communication Systems, Taub and Schilling, TMH, 2nd Edition.
3. Communication Systems, Simon Haykin, John Wiley & Sons Inc, 4th Edition
4. Electronic Communication Systems, W. Tomasi, Pearson Education, 5th Edition

EE – 303 Power Systems- II	L T P	Credits
	3 1 0	4

UNIT I

Review of Power System Components : Synchronous machines, transformers, transmission lines, single line diagram, impedance and reactance diagram, per unit system.

UNIT II

Load Flows : Introduction, bus classifications, nodal admittance matrix (YBUS), development of load flow equations, load flow solution using Gauss-Siedel and Newton-Raphson methods, approximation to N-R method, fast decoupled method, line flow equations.

UNIT III

Economic Operation of Power Systems : Input-output characteristics of thermal and hydro plants, optimum generator allocations without and with transmission losses, penalty factor, incremental transmission loss, transmission loss coefficients and their calculations, hydrothermal scheduling, unit commitment, concept of optimal power flow.

UNIT IV

Symmetrical faults : Concept of Bus impedance matrix and ZBUS building procedure, use of ZBUS in computation of three phase short circuit currents, selection of circuit breakers, use of current limiting reactors.

Text Books/Reference Books :

1. Elements of Power System Analysis, W.D. Stevenson Jr., Mc Graw Hill,1982.
2. Electric Energy Systems Theory – An Introduction, Olle. I. Elgerd, Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition, 2003.
3. Power System Analysis and Design, J.D. Glover, M.S. Sharma & T.J.Overbye, Thomson Learning,2008.
4. Power System Analysis, A.R. Bergen and V. Vittal, Pearson India, 2010.
5. Power System Stability and Control, P. Kundur, TMH.
6. Power System Analysis, Hadi Sadat, Tata McGraw Hill.
7. Power System Analysis, P.S.R. Murthy, B.S. Publications, 2007.

8. Modern Power System Engineering, Kothari & Nagrath, Tata Mc. Graw Hill.
9. Electrical Power System, C.L. Wadhwa, New Age International.
10. Power System Engineering, Chakraborty, Soni, Gupta & Bhatnagar, Dhanpat Rai & Co.

EE-304 Control Systems-II	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Design : The design problem, preliminary considerations of classical design, realization of basic compensators, cascade compensation in time domain cascade compensation in frequency domain, tuning of PID Controllers

UNIT II

State Space Techniques : Concept of state and state variables, various types of state models, state transition matrix and its evaluation, solution of state equations, concepts of controllability and observability, design of control system using pole placement, observer design.

UNIT III

Sampled Data Systems and Digital Control : Difference between continuous, discrete and digital signals, sampling theorem, z-transform and inverse z-transformation, applications in the modeling of sampled data control system, signal reconstruction using ZOH and higher order hold circuits, design of digital controllers using bilinear transforms, ZOH equivalence and pole-zero mapping techniques, stability studies for sampled data systems.

UNIT IV

Non-Linear Systems : Introduction to various types of non-linearities and their transfer characteristics, concept of phase-plane and describing function methods, limit cycle, concept of stability and various methods for study of stability of non-linear systems, Lyapunov's theorem for stability

UNIT V

Recent Advances in Control Systems : Advanced topics relevant to control systems theory and practice

Text Books/Reference Books :

1. Introduction to Feedback Control, Li Qiu and Kemin Zhou, Penguin Books Ltd,2010.
2. Modern Control Engineering, K. Ogata, Prentice-Hall, 5th edition,2010.
3. Control Systems Engineering, Nagrath & Gopal, New Age International, 2009.
4. Digital Control System, Kuo B.C. Oxford University Press, 2nd edition, 2012
5. Digital Control Engineering, M. Sami Fadali and Antonio Visioli, Academic Press Inc, 2nd Revised edition, 2012.
6. Linear Control System Analysis & Design, D' Azzo & Houpis, CRC Press,5th edition, 2003.

EE-305 Microprocessor & Applications	L T P	Credits
	3 1 0	4

UNIT I

Microprocessor Architecture : Functional block diagram, signals, buses, memory and its interfacing, I/O ports and mapping, timing diagram, interrupt structure, concepts of data transfer, basic idea regarding fetching and execution of simple programmes from CPU.

UNIT II

Programming in Assembly Language : Instruction format and addressing modes, assembly language format, and data transfer, data manipulation and control instructions, programming for-loop structure with counting and indexing application of look up table, subroutine, stack operation, polling and interrupt based control transfer.

UNIT III

Peripheral Interfacing : Hand shaking, bidirectional data transfer, study of architecture and programming peripheral interface, 8255 PPI, 8251 USART, 8279 keyboard and display controller, 8253 timer/counter interface, A/D and D/A converter interfacing, serial communication.

UNIT IV

Arithmetic Operators and Algorithms : Fixed point, floating point and fractional arithmetic operations (addition, subtraction, multiplication and division), signed arithmetic, overflow conditions, Boolean algorithm.

UNIT V

Applications : Keyboard and display interface, stepper motor control, applications to measurement and instrumentation, distributed data acquisition system, assessment of power factor, real and reactive power.

Text Books/Reference Books :

1. Microprocessor Architecture: Programming and Applications, R.S. Gaonkar, Wiley Eastern Ltd, New Delhi, 1995.
2. The 8051 Micro Controller and Embedded Systems, Muhammad Ali Mazidi & Janice Gilli Mazdi, Pearson Eduction, 5th Indian reprint, 2003.
3. Microprocessor and Microcontroller Fundamentals: The 8085 and 8051 Hardware and Software ,William Kleitz, Prentice Hall, 1st edition,1997.
4. Microprocessors-Theory and Applications: Intel and Motorola, M. Rafiquzzaman, PHI,1993.
5. Advanced Microprocessor & Interfacing, B. Ram, TMH,2001.
6. Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096, Kant Krishna, PHI,2007.

7. Microcomputer Systems: The 8086/8088 Family Architecture Programming And Design, Gibson Gleen A and Liu Yu-Cheng, 2nd Edition,PHI,2011

EE-306 Control Systems Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding EE-304

EE-307 Digital Electronics and Microprocessor Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding EE-213 and EE-305

EE-308 Power Systems- II Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding to EE-303

EE-309 Minor Project	L T P	Credits
	0 0 4	4

EE – 311 Electrical Drives	L T P	Credits
	3 1 0	4

UNIT I

Dynamics of Electric Drives : Types of loads, quadrant diagram of speed time characteristics, Basic and modified characteristics of dc and ac motors, equalization of load, steady state stability, calculation of time and energy loss, control of electric drives, modes of operation, speed control and drive classifications, closed loop control of drives, selection of motor power rating, class of duty, thermal considerations.

UNIT II

DC Motor Drives : DC motor speed control, Methods of armature control, field weakening, semiconductor controlled drives, starting, braking, transient analysis, controlled rectifier fed dc drives, chopper controlled dc drives.

UNIT- III

Induction Motor Drives : Three phase induction motor starting, braking, transient analysis, speed control from stator and rotor sides, stator voltage control, variable frequency control from voltage sources and current sources, static rotor resistance control, slip power recovery, static Scherbius and static Kramer drive.

UNIT IV

Synchronous Motor Drives : Synchronous motor, operation from fixed frequency supply, starting, pull-in, transients, braking, synchronous motor variable speed drives, modes of variable frequency control, self controlled synchronous motor drive employing load commutated thyristor inverter.

UNIT V

Drives with Special Machines : Introduction to permanent magnet machines, thermal properties of PM, concept of BLDC motor, 120 and 180 operation, rotor position detection, open loop voltage control, closed loop current control, high speed single pulse operation, permanent magnet synchronous machines, rotor position detection and synchronization, sinusoidal PWM excitation, closed and open loop control, PMSG and its application to wind energy, stepper motor, current and voltage control, drive circuits, SRM drive, modeling and analysis of SRM, different configurations of converters, closed and open loop operation, high speed operation with angle of advance.

UNIT VI

Traction Drives : Introduction to solar and battery powered traction drives, space vector modulation, vector control of induction motor, Direct torque control, metro train applications and energy conservation in electrical drives.

Text Books/Reference Books :

1. Utilization of Electrical Energy(SI UNITs) E.OpenshawTaylor, Orient Longman Pvt. Ltd, 2003.
2. Fundamentals of Electrical Drives, Gopal.K.Dubey, Narosa Publishing House, New Delhi, 2002.
3. Power Semiconductor Controlled Drives Gopal.K.Dubey, Prentice Hall , New Jersey.
4. Brushless Permanent Magnet and Reluctance Motor Drives, T.J.E Miller, Oxford University Press
5. Sensorless Vector and Direct torque Control, Peter Vas, Oxford University Press, 1998.
6. Special Electrical Machines, K. Venkataratnam, Universities Press, Hyderabad, 2008.

EE-312 Electrical Machines-III	L T P	Credits
	3 1 0	4

UNIT I

Single phase Asynchronous Motor : Construction, double revolving field theory, starting methods – shaded pole and split phase including capacitor motors, speed torque characteristics, equivalent circuits, phasor diagram and condition for maximum torque, practical determination of equivalent circuit parameters, unbalanced operation as symmetrical two phase machines, symmetrical component concept, applications.

UNIT II

Special Electrical Machines : Principle of operation and performance characteristics of: DC series motor, universal motor, hysteresis motors, permanent magnet synchronous motors, synchronous reluctance motors, switched reluctance motors, brushless dc motors.

UNIT III

Motors used in Control Systems : Stepper motors, DC / AC servomotors, tacho generators.

UNIT IV

Modelling and Analysis of Electrical Machines : Generalized theory of electrical machines, different transformation methods, Park's Transformation, Clarke's Transformation and corresponding equivalent circuits. Representation of three phase asynchronous and synchronous machines in d-q-0 reference frames.

Text Books/Reference Books :

1. Electric Machinery, Fitzgerald, A.E., Charles Kingsley Jr. and Stephen D. Umans, McGraw Hill Book Company, 1992.
2. Principles of Electrical Machines and Power Electronics, P.C. Sen, John Wiley (Indian Edition), 2002.
3. The Performance and Design of AC Commutator Motors, E. Openshaw Taylor, Wheeler Publishing, New Delhi, 1997.
4. Special Electrical Machines, K. Venkataratnam, Universities Press, Hyderabad, 2008.
5. Fractional Horsepower Electrical Machines, E.V. Armensky and G.B. Falk, Mir Publishers, Moscow, 1978.
6. Analysis of Electric Machinery, S. Sudoff, O. Wasynzcuk and P.C. Krause, John Wiley (Indian Edition), 2010.
7. Dynamic Simulation of Electric Machinery, C.M. Ong, Prentice Hall, 1998.

EE – 313 Power System Operation and Control	L T P	Credits
	3 1 0	4

UNIT I

Load Frequency Control: Concept of load frequency control, load frequency control of single area system, effect of governor droop and load damping, block diagram representation of single area system, steady-state frequency error, dynamic response, supplementary control of generating units (PI control), concept of control area, load frequency control of two area system, tie line control, concept of area control error, block diagram representation of two area system, static and dynamic response.

UNIT II

Power System Stability: Stability and stability limit, steady state stability study, derivation of swing equation, transient stability studies by equal area criterion and step-by-step method, factors affecting steady state and transient stability and methods of improvement.

UNIT III

Reactive Power Control: Schematic diagram and block diagram representation, different types of excitation systems, regulating transformers and tap changing, reactive power control, introduction and use of FACTS Controllers.

UNIT IV

Power System State Estimation : State estimation: detection and identification, linear and non-linear models, use of Phasor Measurement UNIT.

Text Books/Reference Books :

1. Power Generation, Operation and Control, A.J. Wood and B.F. Wollenberg, John Wiley and Sons, 2011.
2. Power System Analysis, A.R. Bergen and V. Vittal, Pearson, 2006.
3. Power System Stability and Control, P. Kundur, TMH,2006
4. Power System Analysis, J. Grainger and W. D. Stevenson, TMH, 2006.
5. Electric Energy Systems Theory – An Introduction, Olle. I. Elgerd, Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition, 2003.
6. Flexible AC Transmission Systems, N.G. Hingorani and L. Gyugyi, Wiley India, 2010.
7. Operation and Control in Power Systems, P.S.R. Murthy, BS Publications, Hyderabad.

EE-314: Instrumentation	L T P	Credits
	3 1 0	4

UNIT I

Transducers-I : Definition, advantages of electrical transducers, classification, characteristics, factors affecting the choice of transducers, strain gauges, resistance thermometer, thermistors, thermocouples, LVDT, RVDT

UNIT II

Transducers-II : Capacitive, piezoelectric, Hall effect and opto electronic transducers. measurement of motion, force, pressure, temperature flow and liquid level.

UNIT III

Telemetry : General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System: A/D and D/A converters, analog data acquisition system, digital data acquisition system, modern digital data acquisition system and signal conditioning.

UNIT IV

Display Devices and Recorders : Display devices, storage oscilloscope, DSO, spectrum analyzer, digital recorders. Recent Developments: Introduction to virtual and intelligent instrumentation, fibre optic transducers, smart sensors, smart transmitters, process instrumentation diagrams.

UNIT V

Programmable Logic Controllers : Evolution of PLC-sequential and programmable controllers, architecture and programming of PLC, relay logic and ladder logic, functional blocks, communication networks for PLC, field bus, profi-bus, mod-bus etc.

Text Books/Reference Books :

1. Electronic Instrumentation and Measurement Techniques, W.D. Cooper and A.D. Helfrick, Prentice Hall International.
2. Measurement Systems Application and Design Ernest Doebelin, McGraw- Hill Higher Education, 5th edition, 2003

3. Instrumentation, Measurement and Analysis, B.C. Nakra & K. Chaudhry, Tata Mc Graw Hill, 2nd Edition.
4. Advanced Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai & Sons,2010
5. Process Control Instrumentation Technology, Curtis D. Johnson, Pearson, 6th edition, 1999.
6. Programmable Logic Controllers, Frank D. Petruzella McGraw-Hill Higher Education, 4th edition, 2010.

EE -315 Power Electronic Applications to Power Systems	L T P	Credits
	3 1 0	4

UNIT I

DC Power Transmission Technology : Introduction, comparison of AC and DC transmission, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission. Analysis of HVDC converter: pulse number, choice of converter configuration, simplified analysis of Graetz circuit, analysis with and without ignition delay, commutation overlap.

UNIT II

HVDC System Control : General principles of DC link control, converter control characteristics, combined rectifier and inverter characteristics, alternative inverter control modes, mode stabilization, system control hierarchy, harmonics and filters.

UNIT III

Overview Of Power Quality : Classification of power quality issues, characterization of electric power quality, power acceptability curves, power quality problems, poor load power factor, nonlinear and unbalanced loads, transients, voltage sags and swells, over voltages and under voltages, outage, harmonic distortion, voltage notching, flicker, electrical noise, power quality indices, distortion index, IEEE guidelines and recommended practices

UNIT IV

Power Quality Improvement : Instantaneous reactive power theory, synchronous reference frame theory, instantaneous real and reactive powers, instantaneous symmetrical components, load compensation using DSTATCOM, configuration and control, introduction to dynamic voltage restorer and unified power quality conditioner.

UNIT V

Compensation with FACTS Controllers : Reactive power control in power systems, transmission system compensation, static series and shunt compensations. Voltage sourced converters: concept of voltage sourced converters, multi level and PWM converters. Objectives of shunt compensation, methods of controllable VAR generation, SVC and STATCOM characteristics, comparison between SVC and STATCOM, applications. Objectives of series compensation, principles of TCSC and SSSC, basic operating principles of UPFC.

Text Books/Reference Books :

1. Direct Current Transmission-Vol.I, Edward Wilson Kimbark, John Wiley, 1971.
2. HVDC power transmission system, K.R.Padiyar, NewAge Publishers,2011
3. Understanding FACTS, N.G. Hingorani and L. Gyugyi, IEEE Press, 2000.
4. Power Electronic Control in Electrical Power Systems, E. Acha, Penguin Books Ltd,2008
5. Power System Stability and Control, Prabha Kundur, Tata McGraw-Hill Publishing Company,2006.
6. Facts Controllers In Power Transmission and Distribution, K.R. Padiyar, New Age publishers, 2013
7. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Penguin Books Ltd,2009.
8. Power System Quality Assessment, J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

EE – 316 Power Electronics & Electrical Drives Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding to EE – 301 and EE- 311

EE – 313 Electrical Machines-III / Power System Operation and Control Lab	L T P	Credits
	0 0 2	2

Based on course work corresponding to EE -312 and EE-313

EE – 318 Minor Project-II	L T P	Credits
	0 04	4

EE – 319 Viva Voce Examination on V Semester Industrial Training	L T P	Credits
	0 0 0	2

EE-401 Design of Power Apparatus	L T P	Credits
	3 1 0	4

UNIT I

Factors in Design : Specifications for machines, out-put equation, limitations in design, electric and magnetic loadings, space factor, winding factor and their effects on machine performance, mechanical and high speed problems.

UNIT II

Design of Poly phase Asynchronous Machines : Details of construction, stator design, output equation, separation of D and L, specific loadings, leakage reactance, rotor design, slip ring and squirrel cage motors, harmonic effects and slot combination, magnetizing current and losses, prediction of characteristics.

UNIT III

Design of Synchronous Machines : Details of construction, generators, salient and non salient pole machines, specific loadings and output equation, stator design, harmonics and reduction, armature reaction, design of field winding, short circuit ratio, voltage regulation, efficiency, differences in design between salient and non salient pole machine.

UNIT IV

Design of Transformers : Design of single and three phase transformers, output equation, specific loadings, electro mechanical stresses on windings, no load current, temperature rise.

UNIT V

Thermal aspects of Design : Generation, flow and dissipation of heat losses, thermal capacity, temperature rise curves, ratings of machines, cooling media, ventilation, types of cooling, standard enclosures.

Text Books/Reference Books :

1. Performance and Design of Alternating Current Machines, M.G. Say, CBS Publishers, New Delhi, 2008.
2. Design of Rotating Electrical Machines, Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, Wiley, 1st edition, 2009.
3. The Induction Machines Design Handbook, Ion Boldea, Syed A. Nasar, CRC Press, 2nd edition, 2009.
4. Design and Testing of Electrical Machines, M.V. Deshpande, PHI Learning, 2009.
5. A Course in Electrical Machine. Design, A.K.Sawhney and A. Chakraborty, 'Dhanpat Rai & Co,6th Reprint,2013.
6. Principles Of Electrical Machine Design, R. K. Agarwal , S.K. Kataria & Sons , 2010.

EE-402 Switch Gear & Protection	L T P	Credits
	3 1 0	4

UNIT I

Unsymmetrical Faults : Symmetrical component theory, types of faults, sequence impedances and sequence networks of synchronous machines, transmission lines, transformers, power from sequence variables, sequence network connections for different types of faults – single line to ground, line to line, double line to ground.

UNIT II

Introduction to Protective Schemes : Principles and need for protective schemes, zones of protection and essential quantities of protection, protection schemes, operating principles of relays, universal relays, torque equation, R-X diagram, electromagnetic relays, over current, directional, distance, differential and sequence relays.

UNIT III

Apparatus Protection : Protection of generators, transformers, motors, bus bars and transmission lines. Neutral grounding: necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices.

UNIT IV

Principles of Static Relays : Amplitude and phase comparators, mixing and summation transformer, static IDMT over current and differential relays. Under frequency, over frequency, df/dt relay and its applications, microprocessor based distance relaying, pilot relaying and digital relaying.

UNIT V

Switchgear : Classification of switchgear, arcing phenomenon and principle of arc interruption, AC and DC circuit breaker, different types of circuit breakers and their construction, rating of circuit breakers, features of air blast, vacuum, SF6 circuit breakers, testing of circuit breakers.

Text Books/Reference Books :

1. Protective Relaying: Principles and Applications, J. Lewis Blackburn, Thomas J. Domin, CRC Press, 3rd edition,2006.
2. Computer Relaying for Power Systems, Arun G. Phadke, James S. Thorp, Wiley, 2nd edition, 2009.
3. Power System Protection, Paul M. Anderson, Wiley-IEEE Press,1998.
4. Power System Protection and Switchgear Ravindranath and Chander, New Age Publishers,2nd Reprint,2012
5. Power System Protection, Sunil S. Rao, Khanna Publications, New Delhi.
6. Power System Protection and Switchgear, B. Ram, DH Vishwakarma, Tata McGraw Hill, 2nd Revised edition, 2011.

EE-403 Elective- I	L T P	Credits
	3 1 0	4

Elective-I
EE 403-1 Flexible AC Transmission Systems
EE 403-2 SCADA & Energy Management Systems
EE 403-3 Microwave Engineering
EE 403-4 High Voltage Engineering
EE 403-5 Power Plant Instrumentation
EE403-6 Microcontroller and Embedded Systems
EE 403-7 Electric Traction and High Power Drives
EE 403-8 Robotics and Mechatronics
EE 403-9 Data Communication & Computer Networks

EE-403-1 Flexible AC Transmission Systems	L T P	Credits

UNIT I

Introduction :

Reactive power control in power systems, transmission system compensation, static series and shunt compensation

UNIT II

Voltage Sourced Converters : Concept of voltage sourced converters, multi level and PWM converters, transformer connections for 12 pulse operation, 24 and 48 pulse operations

UNIT III

Static Shunt Compensators- SVC and STATCOM : Objectives of shunt compensation, methods of controllable VAR generation, SVC and STATCOM characteristics, comparison between SVC and STATCOM, steady state and dynamic models of SVC and STATCOM, applications principles

UNIT IV

Static Series Compensators – TCSC and SSSC : Objectives of series compensation, improvement of transient stability and power oscillation damping, sub-synchronous oscillation damping, steady state and dynamic models of TCSC and SSSC, SSR mitigation with TCSC and SSSC, application principles

UNIT V

Combined Compensators – UPFC, IPFC and GUPFC : Basic operating principles of UPFC, independent real and reactive power control capability, control schemes for P and Q control, steady state and dynamic modeling of UPFC, IPFC and GUPFC operating characteristics and control structure, application principles.

Text Books/Reference Books :

1. Understanding FACTS, N.G. Hingorani and L. Gyugyi, IEEE Press, 2000.
2. Power Electronic Control in Electrical Power Systems, E. Acha, Penguin Books Ltd,2008
3. Power System Stability and Control, Prabha Kundur, Tata McGraw-Hill Publishing Company,2006.
4. Facts Controllers In Power Transmission and Distribution, K.R. Padiyar, New Age publishers, 2013
5. Thyristor-Based FACTS Controllers for Electrical Transmission Systems, R. Mohan Mathur, Rajiv K. Varma, Wiley-IEEE Press, 1st edition, 2002.
6. HVDC and FACTS Controllers: Applications of Static Converters in Power Systems,Vijay K. Sood, Springer, 2004.
7. Introduction to FACTS Controllers: Theory, Modeling, and Applications, Kalyan K. Sen, Mey Ling Sen, Wiley-IEEE Press, 1st edition,2009.

EE-403-2 SCADA and Energy Management Systems	L T P	Credits

UNIT I

General Theory : Purpose and necessity, general structure, data acquisition, transmission and monitoring, general power system hierarchical structure, overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, cables, telephone lines, power line carrier, microwaves, fiber- optical channels and satellites.

UNIT II

Supervisory and Control Functions : Data acquisitions, status indications, measured values, energy values, monitoring alarm and event application processing. Control function: ON/OFF control of lines, transformers, capacitors and applications in process industry, valve, opening, closing etc. Regulatory functions: set points and feed back loops, time tagged data, disturbance data collection and analysis, calculation and report preparation.

UNIT III

MAN- Machine Communication : Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities.

UNIT IV

Data bases - SCADA, EMS and network data bases : SCADA system structure - local system, communication system and central system, Configuration- non-redundant single processor, redundant dual processor, multi control centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.

UNIT V

Energy Management Center : Functions performed at a centralized management center, production control and load management, economic dispatch, distributed centers and power pool management.

Text Books/Reference Books :

1. Power System Control Technology, Torsten Cegrell, Prentice Hall International, 1986
2. Scada: Supervisory Control And Data Acquisition, Stuart A. Boyer, The Instrumentation, Systems and Automation Society, 4th edition, 2009.
3. Computer-Based Industrial Control, Krishna Kant, PHI Learning,2nd edition, 2013.
4. Instrument Engineers Handbook, Volume 3: Process Software and Digital Networks, Bela G. Liptak, CRC Press, 4th edition, 2011.
5. Data Communications and Networking, Behrouz Forouzan, McGraw-Hill,5th edition, 2012.

EE-403-3 Microwave Engineering	L T P	Credits

UNIT I

Microwave Network Theory and Passive Devices : S-matrix representation of multiport networks, properties of S-parameters and shifting reference planes, microwave cavities. Microwave hybrid circuits: waveguide tees, hybrid rings, waveguide corners bends and twists, directional

couplers, circulators, isolators, matched load and terminations, co-axial line to waveguide adapters, coupling loops, coupling aperture, short circuit plunger, attenuators, phase shifters, waveguide discontinuities, windows, irises and tuning screws.

UNIT I

Microwave Vacuum Tube Devices : Conventional vaccum devices, Klystrons, multi cavity Klystron amplifiers, reflex Klystron amplifies, Helix Travelling Wave Tubes (TWT), coupled cavity TWT, magnetron oscillators, forward wave and backward wave amplifiers, principles of operation, performance characteristics and application.

UNIT III

Microwave Semiconductor Diodes : Microwave IMPATT devices, TRAPATT diodes BARITE diodes, transfer electron devices (Gunn diodes), tunnel diodes, Schottky barrier diodes, principles of operation, characteristics and applications.

UNIT IV

icrowave Transistors : Microwave bi-polar transistors, Hetero junction transistors, JFETs Metal Semiconductor FETs, high electron mobility transistors, MODFETs, MOS transistors and memory devices, charge coupled devices, principles of operation, characteristics and applications.

UNIT V

Strip lines and Monolithic Microwave Integrated Circuits : Micro-strip lines, parallel strip lines, co-planar and shielded strip lines, MMIC materials, growth, MOSFET fabrication, thin film formation and hybrid IC fabrication.

UNIT VI

icrowave Measurements : Tunable detector, slotted line carriage, VSWR meter, spectrum analyser, network analyser, power measurements, insertion loss and attenuation measurements, VSWR measurements, impedance and frequency measurements, dielectric constant measurements and other passive components measurements.

Text Books/Reference Books :

1. Microwave Devices and Circuits by S.Y. Liao, Prentice Hall, 3rd edition,1996.
2. Microwave Engineering, Sisir Das and Annapurna Das, McGraw-Hill, 2nd edition, 2010
3. Microwave Engineering, David M. Pozar, Wiley, 4th edition, 2011.
4. Microwave Engineering: Passive Circuits, Peter A. Rizzi, Prentice Hall, 1st edition, 1987.
5. Microwaves, K.C. Gupta, New Age International, 2nd edition,2013.

EE-403-4 High Voltage Engineering	L T P	Credits

UNIT I

Generation of High Voltages : Generation HVAC by cascaded transformers, resonance transformers, generation of HVDC by rectifier circuits, electrostatic generators, generation of impulse voltage using Marx's circuits, construction operation and mathematical analysis of simple impulse circuits

UNIT II

Measurement of High Voltages : Use of sphere gaps for the measurement of high voltages, use of high speed C.R.O., brief description of continuously evacuated and sealed off C.R.O., recurrent surge oscillographs and relevant techniques for their measurements, electrostatic voltmeters.

UNIT III

High Voltage Testing of Electrical Equipments : Brief details of the high voltage testing of insulators, transformer, circuit breakers and cables, use of high voltage Schering bridge, concept of non destructive testing, partial discharges.

UNIT IV

Over Voltage Phenomenon : Origin and characteristic of over voltage (surges) on transmission systems, reflection and refraction of traveling waves, lattice diagram, modern theories about lightning, instruments for the measurement of lightning discharge.

UNIT V

Electrical Discharges : Elementary ideas of dielectric breakdown, breakdown of air, discharge in gases, Townsend's mechanism, streamer process, conditions of spark over, mechanism of wet spark over, vacuum breakdown, brief idea about breakdown in solid and liquid dielectrics.

Text Books/Reference Books :

1. High Voltage Engineering Fundamentals, John Kuffel, E. Kuffel, W. S. Zaengl, Newnes, 2nd edition, 2000.
2. High Voltage Engineering, M.S. Naidu and V. Kamaraju, Tata McGraw Hill, Publishing Co., Ltd.,4th edition,2010.
3. High Voltage Engineering, C.L. Wadhwa, New Age International publishers (P) Ltd., 3rd edition,2010.

EE 403-5 Power Plant Instrumentation	L T P	Credits

UNIT I

General scope of Instrumentation :

Measurements on Boiler Plant, Turbo generator Plant and nuclear Reactors.

UNIT II

Fuel Measurement : Pressure Measurement, capsul3es, Bellows and Diaphragm gauges, the bound on tube pressures gauge, pressure transducers.

UNIT III

Temperature Measurements : Steam and water flow measurements, gas analysis meters, smoke measurements in purities in feed water and steam.

UNIT IV

Transducers for Remote Position and Control : Calibration and testing of instrumentation and connected equipment, data loggers and computers.

Text Books/Reference Books :

1. Instrument Engineers' Handbook Process Control, Liptak, Elsevier, 2010
2. Power-plant Control and Instrumentation: The Control of Boilers and Heat-recovery Steam Generator Systems, David Lindsley, Institution of Engineering and Technology, 1st edition, 1999
3. Power Plant Instrumentation, K.Krishnaswamy and M. Ponni Bala, PHI, 2011.

EE 403-6 Micro Controller and Embedded Systems	L T P	Credits

UNIT I

8051 Architecture : Basic organization – 8051 CPU structure, register file, interrupts, timers, port circuits, instruction set, timing diagram, addressing modes, simple program and applications. Peripherals and Interfacing of 8051: typical bus structure, bus memory organization, timing characteristics, extended model and memory interfacing, polling, interfacing basic I/O devices, analog and digital interfacing, PWM mode operation, serial port application.

UNIT II

Peripherals and Interfacing of 8096 : Analog interface, serial ports, watch dog timers, real time clock, multitasking, bus control, memory timing, external ROM and RAM expansion, PWM control, A/D interfacing, PIC microcontroller

UNIT III

Case Study Using 8051 and 8096 : Real time clock, dc motor speed control, generation of gating signals for converters and inverters, frequency measurement, temperature control, organization of a microprocessor, register organization, CPU, description of timing and control units, interfacing memory and I/O devices, synchronous and asynchronous data transfer, interrupt, polling, DMA, introduction to Pentium and pro-Pentium microprocessor, basic organization of 8051, 8097, MC68HC11, PIC16CXX, SLK-51 microcontrollers, instruction set, timing diagram, address modes, simple program and applications.

UNIT IV

Embedded system and their components : Categories of embedded systems, stand alone, real time networked and mobile etc., requirements of embedded systems, reliability, cost effectiveness, low power consumption, efficient use of processing power, efficient use of memory, approximate execution time, challenges and issues in embedded software development, co-design operating system, efficient I/O testing and debugging, hardware architecture for embedded systems, embedded applications.

Text Books/Reference Books :

1. Design with microcontrollers, John B. Peatman, McGraw Hill International, 1989.
2. Intel manual on 16 bit embedded controllers, Santa Clara, 1991.
3. Programming and customizing the 8051 micro controller, Myko Predko, Tata McGraw Hill, 1999.
4. The 8051 Microcontroller and Embedded systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi. Pearson Education, 2004.
5. Microprocessor based design: A Comprehensive guide to effective hardware design, Michael Slater, Prentice Hall, 1989.
6. Design with PIC microcontrollers, John B. Peatman, Pearson Education, 2004

EE 403-7 Electric Traction and High Power Drives	L T P	Credits

UNIT I

Types of Electric Traction and Salient Features : System of track electrification, traction mechanics-types of services, speed time curve and its simplification, average and schedule speeds, tractive effort specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence ,ideal speed torque characteristics of traction motors, series-parallel control of dc traction drives (bridge traction), energy saving, power electronic control of dc and ac traction drives, diesel electric traction.

UNIT II

Constructional and Design Aspects : DC, single phase and 3-phase asynchronous motors for electric traction, constraints and comparison w.r.t. commercial machines, problem associated with voltage rises, temporary interruption of supply, commutation of current rush, ability of motors to withstand current rushes.

UNIT III

Solid-State Device Controllers : DC Traction motors used for starting, speed control and electric braking in electric traction for main line and suburban services, controllers for 1-phase traction motors, trends in main line railways using poly-phase asynchronous motors and their controllers, electric braking requirements and thyristorised controllers.

UNIT IV

Battery operated vehicles for city service Light weight batteries, diesel-electric traction systems for main line service and controllers, soft starting of traction motors, conservation of electrical energy.

UNIT V

Large Power Drives : Power and speed limits: moving up, voltage source converter synchronous motor drives, vector control in voltage source converter SM drives, direct torque and flux control (DTFC),Sensor less control, large motor drives, rectifier - current source inverter for SM drives - basic scheme, rectifier - CSI - SM drive - steady state with load commutation, commutation and steady state equations, Ideal no load speed, speed control options, steady state speed - torque curves, line commutation during starting, drive control loops, direct torque and flux control (DTFC) of rectifier- CSI - SM drives, sub and hyper synchronous. Asynchronous motors cascade drives: limited speed control range for lower P.E.Cs ratings, "Sub and hyper" operation modes, Sub and hyper asynchronous motors cascade control.

Text Books/Reference Books :

1. Advanced Train Control Systems, B. Ning, WIT Press, Southampton, 2010
2. Power Electronics and Motor Drives, Bogdan M. Wilamowski, J. David Irwin CRC Press, 2nd edition, 2011.
3. Modern Electric Hybrid Electric and Fuel Cell Vehicles: Fundamentals Theory and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC Press, 1st edition, 2004
4. AC Electric Motors Control: Advanced Design Techniques and Applications, Fouad Giri, Wiley,1st edition, 2013
5. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi , CRC Press, 2005.

EE 403-8 Robotics & Mechatronics	L T P	Credits

UNIT I

Basic Components of Robotic systems : Kinematics of manipulators, selection of coordinate frames, transformations.

UNIT II

Kinematics and Manipulator Dynamics : Position, velocity and force control, computed torque control, linear and nonlinear controller design of robot.

UNIT III

Mechatronics and its Scope : Definitions, functions of mechatronic systems, classification of sensors and transducers-displacement, position and proximity, velocity, force, pressure and level.

UNIT IV

Actuation Systems : Linear actuators, fast acting actuators, application of solenoid actuators, directional, pressure, process control valve, mechanical actuation systems, electrical actuation systems and mechanical switches.

UNIT V

System Interfacing with Instrumentation and Control System : Mechatronic system, input and output signals of mechatronics system, signal conditioning, filtering and data acquisition system, microprocessor control, microcontroller and programmable logic control system.

Text Books/Reference Books :

1. Robotics and Automation Handbook, Thomas R. Kurfess, CRC Press, 2004
2. Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems, Thomas Bräunl, Springer, 3rd edition, 2008.
3. Mechatronic Systems: Fundamentals Rolf Isermann, Springer, 2005.
4. Mechatronics, W. Bolton, Pearson Education, 4th edition, 2011.
5. Mechatronics, HMT Limited Bangalore (Indian Machine Tool Company), Tata McGraw-Hill Publishing Company, 2000.
6. Mechatronics: An Introduction, Robert H. Bishop, CRC Press, 2005
7. Sensors and Actuators in Mechatronics: Design and Applications, Andrzej M. Pawlak, CRC Press, 2012

EE 403-9 Data Communication & Computer Networks	L T P	Credits

UNIT I

Concepts and Terminology : Advantages of computer networking, review of analog & digital transmission, distributed processing. Network Types: public and private, switched & broadcast networks, local and wide area networks, inter connecting networks, client server computing.

UNIT II

Elements of Computer Communication System : Communication channels (twisted pairs, co-axial cable, optical tube, microwave Seattleite), limitations, bandwidth consideration, channel capacity, Shamnnon- Hartley theorem, data rates, transmission characteristics, transmission techniques (asynchronous and synchronous transmission, serial and parallel, base band & broadband transmission).

UNIT III

Introduction to Modems : Theory principle of operation, types of modems, modulation techniques. Interface: RS 232C, RS 449, RS 442, RS 423A, DTE, DCE, interface with functions of pins (10 only) etc. uses, switching networks, circuit message and packet switching with their advantages and disadvantages, salient features of packet switching and packet network architecture datagram, virtual circuits, X 25 details.

UNIT IV

Local and Wide area Networks : AN topology with their advantages and disadvantages, interconnecting network bridge, gateway, router, brouter, media access control methods, CSMA/CD, high level data link control, general features, types of stations, flow control, error control, framing, transparency, ethernet, 10BASES- standard ethernet, 100 BASE- X fast ethernet, data compression techniques.

UNIT V: Introduction to Architecture and Protocols

ISO reference model, ISDN networks, channels, user access, internet, frame relaying, ATM, routing techniques, multimedia, protocols.

Text Books/Reference Books :

1. Data Communications and Distributed Networks, Black Uyless, Prentice-Hall, 3rd edition, 1994
2. Local Area Networks,James Martin, Joseph Leben, Kathleen KavanaghChapman, Prentice Hall, 2nd edition 1993
3. Computer Networks, Andrew S Tanenbaum, Pearson Education,4th edition, 2012
4. Data Communications Networking Devices: Operation, Utilization and Lan and Wan Internetworking Gilbert Held, Wiley-Blackwell, 4th edition,1998.
5. Data Communication by Prakash C. Gupta, Prentice Hall India,2004.
6. Understanding Data Communication and Networks, William A. Shay, Course Technology Inc, 3rd revised edition, 2003.

Open Elective-I	L T P	Credits
	3 1 0	4

Open Elective-I
EE 404-1 Automotive Systems
EE 404-2 Intelligent Instrumentation
EE 404-3 Advanced Analog Circuit Design
EE 404-4 Restructured Power Systems
EE 404-5 Intellectual property rights and Entrepreneurship
EE 404-6 Biomedical Instrumentation
EE 404-7 Advanced Control Systems
EE 404-8 Non Conventional Energy Systems
EE 404-9 Digital & Optical Communication Systems

EE-404 - 1 Automotive Systems	L T P	Credits
	3 1 0	4

UNIT I

hermo dynamic Engine Cycles : Spark-ignited(SI) engine, diesel engine, seiliger process, gas turbine, sterling engine, engine management systems, emission of IC engine, knock control of SI engine, intermittent fuel injection, injection time calculation, 4 stroke cycle of diesel engine, charge exchange, air-fuel ratio, fuel evaporation, cylinder dynamics, cylinder balancing, diagnostics.

UNIT II

Driveline : Driveline modelling, stationary and dynamic gear shift, driveline control, driveline speed control, transmission-torque control, torque converter, sensor locations, gear shift controller, anti-jerking control, lateral vehicle motion, bicycle model, yaw rate and slip angle, steering control, longitudinal vehicle dynamics, aerodynamic drag force, rolling resistance, calculation of effective tire radius, wheel dynamics, cruise control, anti-lock brake systems, deceleration threshold based algorithms.

UNIT III

Stability Control : Differential braking systems, independent all wheel drive torque distribution, traditional four wheel drive systems, torque transfer between left and right wheels, active control of torque transfer to all wheels, full, half and quarter car suspension models, dependent and independent suspensions

UNIT IV

Vehicular Power Electronic Systems : Multi-converter vehicular dynamics and control, constant power loads and their characteristics, concept of negative impedance instability, negative impedance instability in the single PWM DC/DC Converters, stability of PWM DC/DC converters driving several loads, stability condition in a DC vehicular distribution system, negative impedance stabilizing control for PWM DC/DC converters with constant power and resistive loads, effects of constant power loads in AC vehicular systems, vehicular AC distribution system, negative impedance instability condition, hybrid (DC and AC) vehicular systems with constant power loads, electric and hybrid-electric propulsion systems, modeling of hybrid vehicles, dynamic modeling of electric motors, dynamic modeling of batteries, supercapacitors, dynamic modeling of supercapacitors, electric power links, torque couplers, power split devices.

UNIT V

Hybrid Electric Vehicle : Hybrid definition, engine downsizing, electric vehicle, plug-in hybrid, series hybrid, parallel hybrid, series and parallel hybrid, regenerative braking, brake cooling, aerodynamic drag, and regenerative braking and coasting, time and stopping distance, regenerative braking integrated with conventional hydraulic system, directional stability.

Text Books/Reference Books :

1. Vehicle Dynamics and Control, Rajesh Rajamani, Springer, 2nd edition. 2012
2. Automotive Control Systems: For Engine, Driveline, and Vehicle, Uwe Kiencke, Lars Nielsen, Springer, 2nd edition, 2005.

3. Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles: Land, Sea, Air and Space Vehicles, John M. Miller, Dekker,2007
4. Vehicle Propulsion Systems: Introduction to Modeling and Optimization, Lino Guzzella, Antonio Sciarretta, Springer, 2nd edition, 2007

EE-404 -2 Intelligent Instrumentation	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Intelligent Instrumentation : Historical Perspective, current status, software based instruments.

UNIT II

Virtual Instrumentation : Introduction to graphical programming, data flow & graphical programming techniques, advantage of VI techniques, VIs and sub-VIs loops and charts , arrays, clusters and graphs, case and sequence structures, formula nodes, string and file I/O, Code Interface Nodes and DLL links.

UNIT III

Data Acquisition Methods : Analog and digital IO, counters, timers, basic ADC designs, interfacing methods of DAQ hardware, software structure, use of simple and intermediate Vis, use of data sockets for networked communication and controls.

UNIT IV

PC Hardware Review and Instrumentation Buses : Structure, timing, interrupts, DMA, operating system, ISA, PCI, USB, PCMCIA buses. IEEE488.1 & 488.2 serial interfacing- RS232C, RS422, RS423, RS485; USB, VXI, SCXI, PXI.

UNIT V

Communication Link : PLCC microwave, telephone line, satellite, fibre optic channels.

Text Books/Reference Books :

1. Intelligent Instrumentation: Microprocessor Applications in Measurement and Control, George C. Barney, Prentice Hall, 2nd edition, 1988
2. Measurement and Instrumentation: Theory and Application, Alan S Morris, Reza Langari, Butterworth-Heinemann, 1st edition, 2011
3. PC Interfacing for Laboratory Data Acquisition and Process Control, S. Gupta, J.P. Gupta, Instrument Society of America, 1989
4. LabVIEW Graphical Programming, Gary W. Johnson, Richard Jennings, McGraw-Hill Professional, 4th edition,2006

EE-404-3 Advanced Analog Circuit Design	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Difference in design considerations for discrete and integrated electronic circuits; passive and components available in biopolar and MOS technology brief review of integrated NPN, PNP, lateral PNP, MOSFETS structures, characteristics models.

UNIT II

Basic building blocks of Bipolar and MOS analog ICS Differential amplifier, current sources, current mirrors and current repeaters, voltage references, active loads, level shifters, output stages, voltage to current converters, differential to single ended converters.

UNIT III

IC Op-Amp Architectures : Bipolar op-amp (IC 741) and its DC and small signal ac analysis (voltage gain Zin, Z0 GBP and slew rate), MOS op-amp architectures. IC analog multipliers: Translinear Circuit Principle, Gilbert multiplier cell, (Transconductance multiplier), two and four quadrant multipliers.

UNIT IV

Novel Amplifier Architectures : IC operational transconductance amplifier (OTA), Integrated Norton amplifiers, Current feedback amplifiers, operational transresistance amplifiers (OTRA), current conveyors and their different variants etc.

Recent trends in Analog Circuit design.

Text Books/Reference Books :

1. Microelectronic Circuits: Theory and Applications, Adel S. Sedra, Kenneth C. Smith, Oxford University Press, 6th edition, 2013
2. Applications and Design with Analog Integrated Circuits, Jacob J. Michael, Prentice-Hall, 2nd edition,1996
3. Design with Operational Amplifiers And Analog Integrated Circuits, Sergio Franco, Tata McGraw-Hill Publishing Company, 3rd edition, 2002
4. Design Of Analog CMOS Integrated Circuits,Behzad Razavi, Tata Mcgraw-Hill Publishing Company, 2002.
5. Analog Integrated Circuit Design, David A Johns (Author), Kenneth W Martin, Wiley, 2011.
6. Entrepreneurship and New Venture Creation,V Sharma, A. Sahay, Excel Books, 1st edition, 2012

EE-404-4 Restructured Power Systems	L T P	Credits
	3 1 0	4

UNIT I

Fundamentals of restructured system, market architecture, load elasticity, social welfare maximization.

UNIT II

OPF: Role in vertically integrated systems and in restructured markets, congestion management, optimal bidding, risk assessment and hedging, transmission pricing and tracing of power.

UNIT III

Ancillary services, standard market design, distributed generation in restructured markets, developments in India,

UNIT IV

IT applications in restructured markets, working of restructured power systems, PJM.

Text Books/Reference Books :

1. Understanding Electric Utilities and Deregulation, L.Philipson and H. Lee Willis, Marcel Dekker, 1998.
2. Operation of restructured Power Systems, Kankar Bhattacharya , Math Bollen and J.E. Daadler, Kluwer, 2001.
3. Restructured Electrical Power Systems, M. Shahidepour and M. Alomoush, Marcel Dekker, 2001 .
4. Restructured Power Systems: Engineering and Economics,A. Kumar David, F.S. Wen, Springer-Verlag New York Inc., 2007
5. Restructured Power Systems, S.A. Khaparde, A.R. Abhyankar, Alpha Science International Ltd,2013
6. Restructured Electric Power Systems: Analysis of Electricity Markets with Equilibrium Models,Xiao-Ping Zhang, Wiley-IEEE Press, 1st edition, 2011

EE-404-5 Intellectual Property Rights and Entrepreneurship	L T P	Credits
	3 1 0	4

UNIT I

Basic Principles and acquisition of Intellectual Property Rights : Philosophical aspects of intellectual property laws, basic principles of patent law, patent application procedure, drafting of a patent specification, understanding copyright law, basic principles of trade mark, basic principles of design rights, international background of intellectual property.

UNIT II

Ownership and Enforcement of Intellectual Property Rights : Patent – objectives, rights, assignments, defenses in case of infringement.

UNIT III

Entrepreneurship : Entrepreneurial perspective, start - up strategies, business idea evaluation, business plan writing, introduction to entrepreneurial finance and venture capital, managing growth and delivering innovative products, entrepreneurial opportunities, technologies, business models and personalities, benefit and /or negative impact to creating the new business? (risk tolerances, comfort in low data situations, ability to sell), (judgment, ability to coordinate with many), (scope, risk, return expectation).

Text Books/Reference Books :

1. Intellectual Property Rights,Prabuddha Ganguli, Tata Mcgraw Hill,2013
2. Intellectual Property Rights: Creation, Development, and Protection (Strategic Management), O'Connor, Business Expert Press, 2012
3. Intellectual Property Rights: Text and Cases, R. Radhakrishnan and S. Balasubramanian, Excel Books,2008
4. Intellectual Property Rights: Basic Concepts,M. M. S. Karki, Atlantic,2009.
5. Intellectual Property Rights: A Primer, Anita Rao, Bhanoji V. Rao, Eastern Book Co, 2010

EE-404-6 Bio- Medical Instrumentation	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Bio-Medical Instrumentation Systems : Specifications of bio-medical instrumentation system, man-instrumentation system components, problems encountered in measuring a living system, basics of anatomy and physiology of the body. Bioelectric potentials: resting and action potentials, propagation of action potential, The physiological potentials –ECG, EEG, EMG, ERG, EOG and evoked responses

UNIT II

Electrodes and Transducers : Electrode theory, bio-potential electrodes, surface electrodes, needle electrodes, microelectrodes, bio-medical transducer. Cardiovascular Measurements: Electrocardiography, ECG amplifiers, electrodes and leads, ECG recorders, single channel, three channel, vector cardiographs, ECG System for Stresses testing, Holter recording, blood pressure measurement, heart sound measurement, pacemakers and defibrillators.

UNIT III

Patient Care & Monitoring : Elements of intensive care monitoring, displays, diagnosis, calibration and reparability of patient monitoring equipment. Respiratory system Measurements: physiology of respiratory system, measurement of breathing mechanism, spirometer, respiratory therapy equipments, inhalators, ventilators and respirators, humidifiers, nebulizers and aspirators.

UNIT IV

Nervous System Measurements : Physiology of nervous system, Neuronal communication, Neuronal firing measurements. Ophthalmology Instruments: Electroretinogram, Electrooculogram, Ophthalmoscope, Tonometer for eye pressure measurement. Diagnostic techniques: ultrasonic diagnosis, eco-cardiography, eco-encephalography, ophthalmic scans, X-ray and radio-isotope diagnosis and therapy, CAT-Scan, emission computerized tomography, MRI.

UNIT V

Bio-Telemetry : Components of a bio-telemetry system, implantable units, telemetry for ECG measurements during exercise, for Emergency patient monitoring. prosthetic devices and therapies: hearing aides, myo-electric arm, dia-thermy, laser applications in medicine.:

Text Books/Reference Books :

1. Bioinstrumentation, John G. Webster, John Wiley & Sons,2008.
2. Biomedical Instrumentation and Measurements, Cromwell Leslie, Weibell Fred J. , Pfeiffer Eric A, Prentice-Hall, 2nd edition, 1990
3. Introduction to Biomedical Equipment Technology, Joseph J. Carr, John M. Brown, Pearson Education, 2002.
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, Robert B. Northrop, CRC Press, 2nd edition, 2012
5. Biomedical Instrumentation: Technology and Applications, R. S. Khandpur, McGraw-Hill Professional, 2004
6. Biomedical Electronics and Instrumentation, S K Venkata Ram, Galgotia Publications Pvt Ltd, 2000
7. A Textbook of Medical Instruments,S. Ananthi, New Age International Pvt Ltd Publishers,2006

EE-404-7 Advanced Control Systems	L T P	Credits
	3 1 0	4

UNIT I

Non-Linear Systems : Types of non-linearity, typical examples, equivalent linearization describing functions, phase plane analysis, limit cycle, concept of stability and various methods for study of stability of non-linear systems

UNIT II

Non-Linear System control : Various notions of stability, stability techniques of Lyapunov and Popov, nonlinear controller design using feedback linearization and back stepping method, introduction to variable structure control systems.

UNIT III

Classification of Adaptive control : Auto tuning and Self Tuning Regulators (STR), Model Reference Adaptive control (MRAC), types of STR and MRAC, different approaches to self-tuning regulators, stochastic adaptive control, gain scheduling.

UNIT IV

Application of Adaptive control : Recent trends in self-tuning, stability, convergence and robustness studies, model updating, general purpose adaptive regulator, applications to process control.

UNIT V

Identification : On line identification using recursive least squares, minimum variance algorithm, stochastic approximation and maximum likelihood method, simultaneous state and parameter estimation, extended Kalman filter, two stage identification methods, nonlinear identification, model reference adaptive control.

Text Books/Reference Books :

1. Adaptive Control: Stability, Convergence and Robustness, Shankar Sastry and Marc Bodson, Dover Publications Inc., 2011
2. Adaptive Control, Karl J. Astrom and Bjoran Wittenmark, Pearson Education , 2nd edition ,2003.
3. Adaptive Control Systems: Techniques and Applications, V.V.Chalam, CRC Press, 1987
4. System Identification: Theory for the User, Lennart Ljung, Prentice Hall, 2nd edition,1998
5. Filtering and System Identification: A Least Squares Approach, Michel Verhaegen, Vincent Verdult, Cambridge University Press, 2012
6. Nonlinear System Identification: From Classical Approaches to Neural Networks and Fuzzy Models, Oliver Nelles, Springer, 2000

EE-404-8 Non Conventional Energy Systems	L T P	Credits
	3 1 0	4

UNIT I

Introduction to Non Conventional Energy Systems : Various non-conventional energy resources Introduction, availability, classification, relative merits and demerits. Solar Cells: theory of solar cells, solar cell materials, solar cell array, solar cell power plant, limitations. Solar Thermal Energy: solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance, solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

UNIT II

Geothermal Energy : Resources of geothermal energy, thermodynamics of geo-thermal energy conversion, electrical conversion, non-electrical conversion, environmental considerations. Magneto-hydrodynamics (MHD): principle of working of MHD power plant, performance and limitations. Fuel Cells: principle of working of various types of fuel cells, performance and limitations.

UNIT III

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

UNIT IV

Energy from Bio-mass, Ocean Thermal, Wave and bio-waste : Availability of bio-mass and its conversion principles, ocean thermal energy conversion principles, performance and limitations, wave and tidal energy conversion principles, performance and limitations, bio-waste recycling power plants.

Text Books/Reference Books :

1. Renewable Energy Resources, John Twidell, Tony Weir, Taylor and Francis, 2nd edition, 2005.
2. Solar Engineering of Thermal Processes,John A. Duffie, William A. Beckman, John Wiley & Sons, 4th edition, 2013
3. Biofuels, Solar and Wind as Renewable Energy Systems: Benefits and Risks,D. Pimentel, Springer,1st edition,2010
4. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers,Chetan Singh Solanki, PHI Learning,2013.
5. Non Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd, 2006

EE-409 Digital and Optical Communication Systems	L T P	Credits
	0 0 3	3

UNIT I

Digital Communication Systems : Signal representation, statistical decision theory, introduction to digital communication, sampling theorem, random signals and noise, signal to noise ratio.

UNIT II

Waveform Coding Techniques : Pulse Code Modulation (PCM), quantization noise, bandwidth, advantages over analog communication, PCM system, differential PCM, digital modulation, digital multiplexing, TDMA. CDMA and OFDM.

UNIT III

Optical Fibre Communications : Block diagram of optical fiber communication systems, advantages of optical fiber communication. Optical fiber waveguides: structure of optical wave guide, light propagation in optical fiber using ray theory, acceptance angle, numerical aperture, skew rays, wave theory for optical propagation, modes in a planar and cylindrical guide, mode volume, single mode fibers, cutoff wavelength, mode field diameter, effective refractive index and group and mode delay factor for single mode fiber.

UNIT IV

Characteristics of Optical Fiber : Attenuation in optical fibers intrinsic and extrinsic absorption, linear and non linear scattering losses, fiber bend losses. dispersion and pulse broadening, intra modal and intermodal dispersion for step and graded index fibers, modal noise, over all fiber dispersion for multimode and mono mode fiber, dispersion shifted fibers, modal birefringence and polarization maintaining fibers

UNIT V

Optical Sources : Basic concepts Einstein relations and population inversion optical feedback and threshold conditions, direct and indirect band gap semiconductors spontaneous and stimulated emission in p-n junction, threshold current density, hetero junction and DH structure, semiconductor injection lasers, structure and characteristics of injection laser, drawbacks and advantages of LED, DH structures and characteristics.

Text Books/Reference Books :

1. Digital Communications, Simon Haykin, John Wiley and Sons,1988
2. Optical Fiber Communication, Gerd Keiser, Tata McGraw Hill Education,5th edition, 2013
3. Optical Communication Systems,John Gowar, Prentice Hall, 2nd edition, 1993
4. Optical Fiber Communications, Senior, Pearson Education,3rd edition, 2009

EE – 405 Design of Power Apparatus Lab	L T P	Credits
	0 0 3	3

Based on the course work corresponding to EE-401

EE – 406 Switchgear & Protection Lab	L T P	Credits
	0 0 3	3

Based on the course work corresponding to EE-402

EE – 407 Viva Voce Examination on VI Semester Industrial Training	L T P	Credits
	0 0 0	4

EE – 408 Major Project- I	L T P	Credits
	0 0 4	4

EE-411 DSP and its Applications to Electromechanical Systems	L T P	Credits
	3 1 0	4

UNIT I

Introduction : Classification of Systems: Continuous, discrete, linear, causal, stable dynamic recursive, time variant, Classification of Signals: continuous and discrete energy and power, mathematical representation of signals, spectral density, sampling techniques, quantization, quantization error, Nyquist state and aliasing effect, digital signal representation, analog to digital conversion

UNIT II

Discrete Time System Analysis : Z- transform and its properties, Inverse Z Transform, difference equation, solution by Z-transform, application to discrete System, stability analysis, frequency response, convolution, Fourier transform of discrete sequence, discrete Fourier series

UNIT III

Discrete Fourier Transform & Computation : Properties, magnitude and phase representation, computation of DFT using –DIT and DIF, FFT using radix 2, Butterfly structure

UNIT IV

Programmable DSP Chips : Architecture and features of TMS320C54 signal processing chip, quantization effects

UNIT V

Applications of DSP in Control of Electrical Machines : DSP based control of Induction motors, stepper motors, BLDC motors, PMSM, SRM and implementation of motor control system using LF2407.

Text Books/Reference Books :

1. Digital Signal Processing: Principles, Algorithms, and Applications, John G Proakis, Dimitris G Manolakis, 4th edition, Pearson, 2007
2. Digital Signal Processing, Sanjit Mitra, Tata McGraw-Hill Publishing Company,3rd edition, 2007
3. Digital Signal Processing, Oppenheim Alan V, Schafer Ronald W, Prentice-Hall,1988
4. Digital Signal Processing: System Analysis and Design, Paulo Sergio Ramirez Diniz, Eduardo A. B. Da Silva, Sergio L. Netto, Cambridge University Press, 2005
5. Digital Signal Processing: An Introduction with MATLAB and Applications, Zahir M. Hussain, Amin Z. Sadik, Peter O'Shea, Springer, 2011
6. DSP-Based Electromechanical Motion Control, Hamid A. Toliyat, Steven G. Campbell, CRC Press, 2003

EE 411 DSP and its applications to Electromechanical Systems	L T P	Credits
	3 1 0	4

EE-412 Elective-II	L T P	Credits
	3 1 0	4

Elective-II
*EE 412-1 Distributed Generation Systems
*EE 412-2 Switch Mode Power Supplies
*EE 412-3 Power Quality and Energy Conversation
EE 412-4 Power System Dynamics & Stability
*EE 412-5 Smart Grid
EE 412-6 Utilization of Electrical Energy
EE 412-7 HVDC Transmission
*EE 412-8 Digital Image Processing
*EE 412-9 Electrical Storage Systems
*EE 412-10 Microwave Integrated Circuits
EE 412-11 Energy Auditing, Conservation and Management

EE-412-1 Distributed Generation Systems	L T P	Credits

UNIT I

Distributed Generation : Electricity generation in transition, distributed generation with fossil fuels, concentrating solar power (CSP) technologies, biomass for electricity, micro-hydropower systems, fuel cells and wind energy based generation, asynchronous generators.

UNIT II

Control of Wind Energy Systems : Overview of wind turbine control systems, typical grid-connected turbine operation, supervisory control overview and implementation, dynamic control theory and implementation, Solar Photovoltaic Power System: solar commercial power plants, Energy Storage: various batteries and their equivalent electrical circuit, performance characteristics, battery charging, battery management, flywheel, compressed air and superconducting coil.

UNIT III

Stand-Alone System : PV stand-alone, wind stand-alone, hybrid system, hybrid with diesel, hybrid with fuel cell, mode controller, load sharing, system sizing, power and energy estimates, battery sizing, PV array sizing, wind farm sizing.

UNIT IV

Grid-Connected System : Interface requirements, synchronizing with grid, inrush current, synchronous operation, load transient, safety, operating limit, voltage regulation, stability limit, energy storage and load scheduling, utility resource planning tool, Electrical Performance: voltage current and power relations, component design for maximum efficiency, electrical system model, static bus impedance and voltage regulation, dynamic bus impedance and ripple, harmonics, quality of power, harmonic distortion, voltage transients and sags, voltage flickers, renewable capacity limit, system stiffness, interfacing standards, lightning protection. Economics of Distributed Resources

UNIT V

UPS & Battery Energy Storage Systems : Uninterruptible power supplies, applications of ups systems , distributed approach, centralized approach, power factor correction in ups systems, battery energy storage systems, grid synchronization, storage & power conditioning modes, wind and solar power systems.

Text Books/Reference Books :

1. Integration of Distributed Generation in the Power System, Math H. Bollen, Fainan Hassan, Wiley-Blackwell, 2011.
2. Distributed Generation, Nick Jenkins, G. Strbac, J. B. Ekanayake, Institution of Engineering and Technology, 2009

3. Wind and Solar Power Systems: Design, Analysis, and Operation, Mukund R. Patel, CRC Press, 2nd edition, 2005
4. Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley-Blackwell, 2nd edition, 2013
5. Power Quality: Mitigation Technologies in a Distributed Environment, Antonio Moreno-Muñoz, Springer,1st edition, 2010.
6. Variable Speed Generators, Boldea Ion, CRC Press, 2012.

EE-412-2 Switched Mode Power Supplies	L T P	Credits

UNIT I

Introduction : Classification of Power Supplies, Basic Functions of Voltage Regulators, Power Relationships in DC–DC Converters, Topologies of PWM DC–DC Converters.

UNIT II

Buck, Boost PWM DC–DC Converter : Analysis of PWM Buck, Boost & Buck-Boost Converter. Design of Buck, Boost & Buck-Boost Converters. Power Losses and Efficiency of Buck, Boost & Buck-Boost Converters.

UNIT III

Flyback and Forward PWM DC–DC Converter : Introduction, Transformers, DC Analysis of PWM Flyback and Forward Converter, Boundary between CCM and DCM, Ripple Voltage in Converter, Power Losses and Efficiency of Converter, Multiple-output Converters, Bidirectional Converter.

UNIT IV

Half, Full-bridge & Push-Pull PWM DC–DC Converter : Introduction, DC Analysis of PWM Half, Full-bridge & Push Pull Converter, Boundary between CCM and DCM, Ripple Voltage in Converters, Power Losses and Efficiency of Converters, Phase-controlled Full-bridge Converter, Comparison of PWM DC–DC Converters.

UNIT V

Soft-switching DC–DC Converters : Introduction, Zero-voltage-switching DC–DC Converters, Buck ZVS Quasi-resonant DC–DC Converter, Multi resonant Converters.

Text Books/Reference Books :

1. Pulse-width Modulated DC–DC Power Converters, Marian K. Kazimierczuk, John Wiley & Sons, 2008.
2. Switch-Mode Power Supplies Spice Simulations and Practical Designs, Christophe Basso, Mc-Graw Hill, 2008
3. Switching Power Supply Design, Abraham Pressman, Keith Billings and Taylor Morey, Mc Graw Hill, 2009
4. Switch-Mode Power Supply Simulation: Designing with SPICE, Steven M. Sandler, McGraw-Hill, 2005
5. Switch-Mode Power Converters: Design and Analysis, Keng C. Wu, Elsevier Science Publishing, 2005
6. Switch Mode Power Conversion, K. Kit Sum, Marcel Dekker, 1984

EE-412-3 Power Quality and Energy Conservation	L T P	Credits

UNIT I

Overview of Power Quality : Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

UNIT II

Measurement and Analysis Methods : Voltage, current, power and energy measurements, power factor measurement and definitions, event recorders, measurement error, analysis in the periodic steady state, time domain method, frequency domain methods, Fourier and Hartley transform, Welsh Transform, Wavelet Transform, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

UNIT III

Harmonics & Voltage Fluctuations : Sources and effect of harmonics and inter harmonics, current injection methods, harmonic power flow studies using Newton-Raphson method, application of power flow studies, voltage fluctuations, flicker and impulses, high frequency issues, common mode and transverse mode noise, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

UNIT IV

Power Quality Improvement : Utility- Customer interface, harmonic filter: passive, active and hybrid filter, phase multiplication methods and transformer connections, network reconfiguring devices, load compensation using DSTATCOM, voltage regulation using DSTATCOM, uninterruptible power sources, BESS, protecting sensitive loads using DVR, UPQC.

UNIT V

Energy Audit and Conservation : Energy audit concepts, need and types of energy audit, mass and energy balances, energy management (audit) approach, energy audit instruments; bench marking, energy performance, matching energy use to requirement, energy conservation act; duties and responsibilities of energy manager and auditors. some case study examples.

Text Books/Reference Books :

1. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2002.
2. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008
3. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011
4. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011
5. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007
6. Power Quality, C. Sankaran, CRC Press, 2001
7. Electric Power Quality, Surajit Chattopadhyay, Madhuchhanda Mitra, Samarjit Sengupta, Springer, 2011
8. Handbook on Energy Audit and Environment Management,Y.P. Abbi, Shashank Jain, The Energy and Resources Institute, TERI, 2009

EE-412-4 Power System Dynamics and Stability	L T P	Credits

UNIT I

The Stability Problem : Origin of the stability problem, definition of stability terms, power angle diagrams.

UNIT II

Steady State Stability : The steady state power limits of simple systems with synchronous loads-analytical and graphical methods, methods of improving steady state stability limits, elementary aspects of dynamic stability.

UNIT III

Transient Stability : Review of the laws of mechanics, swing equation for a single machine connected to an infinite bus, net-work reduction techniques, equal areas criterion of stability, solution of wing equation by numerical methods (step by step solution), Runge kutta method. Critical clearing angle and time, analysis of two finite machine system and multimachine systems, effect of grounding on stability, methods of improving the transient stability, role of AVR.

UNIT IV

Small Signal Stability : Synchronising and damping torques, modes of oscillations, significance of rotor mode eigenvalues, participation factors, power oscillation damping, supplementary control, Power system stabilisers, role of FACTS devices

UNIT V

Voltage Stability : Voltage Stability, P-V Curves methods of improving stability, Reactive Power Flow, Reactive Power Transmission, HVDC Operations, Introduction to FACTS devices, and Enhancement of stability by application of FACTS devices.

Text Books/Reference Books :

1. Power System Stability and Control, Prabha Kundur, Tata McGraw-Hill Publishing Company,2006.
2. Power System Dynamics And Stability, Peter W. Sauer, M.A. Pai, Prentice Hall,1st edition,1997
3. Power System Dynamics Stability And Control, Padiyar K R, BS Publications,2003
4. Understanding FACTS, N.G. Hingorani and L. Gyugyi, IEEE Press, 2000.
5. Facts Controllers In Power Transmission and Distribution, K.R. Padiyar, New Age publishers, 2013
6. Thyristor-Based FACTS Controllers for Electrical Transmission Systems, R. Mohan Mathur, Rajiv K. Varma, Wiley-IEEE Press, 1st edition, 2002.
7. Power Systems Analysis, Hadi Saadat, McGraw-Hill Higher Education, 2nd edition, 2004

EE-412-5 Smart Grid	L T P	Credits

UNIT I

Introduction : Structure and fundamental problems of electrical power systems, principles of electrical power control, classical power theory & instantaneous power theory power, flow control, distributed generation and energy storage benefits to grids, solutions of control in smart power systems, damping of the system oscillations, power quality control, fully integrated power system-the smart grid, smart electrical energy networks concept-microgrids & picogrids, Distributed Generation and Microgrid: active distribution network, microgrid configuration, interconnection of microgrids, technical and economical advantages and challenges of microgrid, distribution system issues of microgrid, power quality, operational issues of a microgrid, dynamic interactions of microgrid with main grid, ride through, grid synchronization, syncrophasors.

UNIT II

Distributed Energy Resources : Variable and adjustable speed generation systems (SEIG & DFIG), wind energy conversion systems (WECS), grid integration of wind energy systems, power curves of WECs, grid coupling, reactive power requirements, power fluctuations, harmonics and flicker, offshore wind energy systems, grid integration of photovoltaics and fuel cells, grid interfacing and islanding detection, dynamics of small-scale hydroelectric power generation, other renewable energy sources, dynamics of storage systems, special cases-superconducting magnet energy storage & supercapacitors, application of energy storage devices, microgrid and active distribution network management system:network management needs of microgrid, microsource generation control, domestic process control, energy storage, regulation and load shifting, microsource controller, integrated communications architecture, energy management, demand-side management, dynamic energy management, decentralized operation, protection co-ordination.

UNIT III

Protection Issues for Microgrids : Different islanding scenarios, major protection issues of stand-alone microgrid, single generator and generator operating in parallel with other generators on an isolated network, microgrid distribution system protection, protection of microsources, overcurrent protection of the generator intertie, negative sequence overcurrent protection, directional control, earth fault overcurrent protection, distribution transformer protection, under/overvoltage protection, under/overfrequency protection, reverse power relay, unbalanced loading, loss of mains protection, rate of change of frequency, vector shift, neutral grounding requirements,power electronic interfaces: overview of power converter and controls, PWM rectifiers, two level and multi-level converters, neutral point clamped voltage source converter(VSC), space vector PWM, Z-source converters, operation principle of the voltage z-inverter, three-level and four-wire inverters with z-source, grid-imposed frequency, VSC system- control in ⍰⍰-⍰ & d-q-frames, D-STATCOM, SSSC, UPFC, Back-to-Back HVDC conversion system, interconnection with a hosting grid – parallel operation, integration and interconnection concerns, voltage and current control of a 3-phase 4 wire distributed interface converters in islanded mode.

UNIT IV

Power Quality and Reliability issues of Distributed Generation(DG) : Power quality disturbances – transients, voltage sags and swells, over-voltages and under-voltages, outage, harmonic distortion, voltage notching, flicker, electrical noise, power quality sensitive loads, existing power quality improvement technologies- preventive(alternative power supplies) technologies, curative(power-conditioning technologies), load compensation, voltage regulation, harmonic filtration and balancing of the voltage in three-wire systems, dynamic voltage restorer, primary & secondary DG system with power quality support, soft grid-connected DG, DG with intermittent solar PV, DG with intermittent wind generator, controllers with energy-storage systems, ultra-high reliability scheme using dual link dc bus, issues of premium power in DG integration.

UNIT V

SCADA and Active Distribution Networks : Overview of existing distributed network operator (DNO) SCADA systems, control of DNO SCADA systems (centralised & distributed), requirement of communication in microgrids, SCADA in microgrids, SCADA communication infrastructure, distributed control system (DCS), microgrid control, sub-station communication standardisation, smart appliances, smart transformers, online condition monitoring, SCADA communication and control architecture, automated meter reading, communication devices and media, operational issues of serial communication, broadband power line communication, optical & wireless communication.

Text Books/Reference Books :

1. Microgrids and Active Distribution Network – S. Chowdhary, P. Crossley, IET 2009
2. Embedded Generation,N. Jenkins, R. Allan, P. Crossley, D. Kirschen, G. Strbac, Institution of Engineering and Technology, 2000
3. Power Electronics in Smart Electrical Energy Networks- R. Strzelecki, G. Benesek, Springer
4. Voltage Sourced Converters in Power Systems: Modeling, Control, and Applications, Amirnaser Yazdani, Reza Iravani, John Wiley & Sons Inc, 2010

EE-412-6 Utilization of Electrical Energy	L T P	Credits

UNIT I

Illumination Essentials : Nature of light, visibility spectrum curve, luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux. laws of illumination, construction and working of incandescent and discharge lamps, their characteristics, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp, street lighting, flood lighting, monument lighting and decorative lighting, light characteristics.LED lighting & Design of Illumination Systems: equivalent circuit to an LED, voltage drop versus color and current , LED drivers- voltage source/ current source ,linear power supplies, DC-DC power converters, power factor corrected converters, design and selection of components, magnetics & transformers, magnetic saturation, EMI an EMC issues, thermal considerations, heat sinks, safety issues, calculation of number of light points for interior and exterior illumination, design problems, illumination levels, illumination for automobile systems.

UNIT II

Electric Heating : Advantages of electrical heating Heating methods Resistance heating – direct and indirect resistance heating, eletctric ovens, their temperature range, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit Induction heating; principle of core type and coreless induction furnace Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace Dielectric heating, applications in various industrial fields Infra-red heating and its applications, microwave heating.

UNIT III

Electric Welding : Spot welding, projection seam and butt welding and welding equipments used, principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method of and their applications. power supply for welding, coated

electrodes, comparison between AC and DC arc welding, high frequency welding, welding control circuits, welding of aluminium and copper introduction to TIG, MIG welding.

UNIT IV

Electrolytic Processes : Need of electro-deposition laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing, buffing equipment and accessories for electroplating factors affecting electro-deposition , principle of galvanizing and its applications, anodising and its applications, electroplating on non-conducting materials, manufacture of chemicals by electrolytic process, electrolysis for water purification.

UNIT V

Refrigeration and Air Conditioning and Water Coolers : Principle of air conditioning, vapour pressure, refrigeration cycle, eco-friendly refrigerants, description of electrical circuit used in a) refrigerator, b) air-conditioner, and c) water cooler, variable speed drive for compressors, high speed compressors, insta-chill, Peltier effect, thermoelectric cooling, sterling engines, solar concentrator heating and cooling,

Text Books/Reference Books :

1. Utilization of Electric Energy in SI UNITs, E.O. Taylor, Universities Press,1981
2. Generation Distribution and Utilization of Electrical Energy. C.L. Wadhwa, New Age International Publishers, 2010
3. Art and Science of Utilization of Electrical Energy by H Partap, Dhanpat Rai & Sons.

EE-412-7 HVDC Transmission	L T P	Credits

UNIT I

DC Power Transmission Technology : Introduction-comparison of AC and DC transmission application of DC transmission-description of DC transmission system planning for HVDC transmission-modern trends in DC transmission

UNIT II

Analysis of HVDC Converter : Pulse number, choice of converter configuration-simplified analysis of Graetz circuit-converter bridge characterstics-characterstics of twelve pulse converter –detailed analysis of converters.

UNIT III

HVDC Converter and System Control : General principles of DC link control-converter control characteristics-system control hierarchy –firing angle control-current and extinction angle control-starting and stopping of DC link power control higher level controllers-telecommunication requirements.

UNIT IV

Harmonics and Filters : Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

UNIT V

Simulations of HVDC Systems : Introduction –system simulation: Philosophy and tools-HVDC system simulation-modeling of HVDC systems for digital dynamic simulation.

Text Books/Reference Books :

1. HVDC power transmission system, Padiyar,K.R. Wiley Eastern Limited, 1st edition.1990
2. Direct Current Transmission, Edward Wilson Kimbark, Wiley Interscience, 1971.
3. Extra high Voltage AC transmission Engineering, Rakosh Das Begamudre, New Age International, 1990
4. High Voltage Direct Current Transmission, Arillaga,J, Peter Pregrinus,London,1983.

EE 412-8 Digital Image Processing	L T P	Credits

UNIT I

Introduction : Digital image fundamentals, digital image through scanner, digital camera, concept of gray levels, gray level to binary image conversion, sampling and quantization, relationship between pixels, imaging geometry.

UNIT II

Image Transforms : 2-D FFT, properties, Walsh transform, Hadamard transform, discrete cosine transform, Haar transform, Slant transform, Hotelling transform.

UNIT III

Image Processing : Image enhancement, point processing, histogram processing, spatial filtering, enhancement in frequency domain, image smoothing, image sharpening. Colour image processing: Pseudo colour image processing, full colour image processing.

UNIT IV

Image Restoration and Segmentation : Image restoration degradation model, algebraic approach to restoration, inverse filtering, least mean square filters, constrained least squares restoration, interactive restoration. Image segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region oriented segmentation.

UNIT V

Image Compression : Image compression redundancies and their removal methods, fidelity criteria, image compression models, source encoder and decoder, error free compression, lossy compression.

Text Books/Reference Books :

1. Digital Image processing, R.C. Gonzalez, R.E. Woods, Addison Wesley, 2nd edition, 2002.
2. Digital Image Processing, William K. Pratt, John Wiley, 3rd edition, 2004.
3. Fundamentals of Electronic Image Processing, Weeks Jr., PHI.
4. Fundamentals of Digital Image Processing, A.K.Jain, PHI.

EE 412-9 Electrical Storage Systems	L T P	Credits

UNIT I

Battery : Introduction, energy storage parameters, lead–acid batteries constructional features, battery charge–discharge cycles operating limits and parameters, maintenance, sizing, types, applications, performance measurement, charging and discharging of a battery, storage density, energy density, and safety issues in lead-acid, nickel-cadmium, zinc manganese dioxide batteries, modern batteries as zinc-air, nickel hydride, lithium battery, flow batteries.

UNIT II

Valve Regulated Lead Acid Batteries : The valve-regulated battery, valve-regulated battery, heat management in lead–acid batteries, heat generation, heat dissipation, lead alloys for valve-regulated lead–acid batteries, hardening mechanism in lead–calcium alloys, aluminum addition, formation of structure of positive and negative active masses, manufacture of lead–acid battery plates, soaking and formation phenomena, positive-plate additives to enhance formation and battery performance, modeling the effects of additives, conductive additive, negative-plate additives, function of the separator in the VRLA battery, characteristics of absorptive glass materials, separator properties and function, separator materials, applications in automotive applications, telecommunications and UPS Applications, remote-area power-supply systems(RAPS), recovery and recycling of lead–acid batteries

UNIT III

Ultra Capacitors / Super Capacitors : Introduction, double-layer ultra capacitors, high-energy ultra capacitors, rating, size and applications, super capacitors, basic components of super capacitors, several types of electrodes and electrolytes, electrode materials, high surface area activated carbons, metal oxide, conducting polymers, types of electrolyte, disadvantages, advantages of super capacitors, comparison with battery systems, applications in public transport vehicles, private vehicles, and consumer electronics, aspects of energy density, power density, price, and market.

UNIT IV

Fuel Cell : Fuel cells for direct energy conversion by electro chemical means, focus on the maximum intrinsic efficiency of an electrochemical converter, physical interpretation of the Carnot efficiency factor, electro chemical energy convertors, power outputs, types of fuel cells, hydrogen oxygen cells, hydrogen air cell, hydrocarbon air cell, alkaline fuel cell, and phosphoric and fuel cell, detailed analysis of the advantages and drawbacks. Other Storages: pumped hydroelectric energy storage, storage capabilities of pumped systems, compressed air energy storage, storage heat , energy storage as an economic resource, flywheels, advanced performance of flywheels, applications of flywheels, design strategies, superconducting magnetic storage system, SMES system capabilities , developments in SMES systems.

UNIT V

Power Electronics for Charging Control : Battery management systems, battery data acquisition, battery state-of-charge, control of charge and discharge, multiple battery systems, thermal management of batteries, safety management of batteries, charging techniques for VRLA batteries, constant-voltage charging, constant-current charging, constant voltage–constant current combinations, taper-current charging, pulsed-current charging, charging of VRLA products, oxygen cycle and saturation effects, overcharge processes, ac-dc and dc-dc converters, isolated converters, multi pulse converters, multilevel converters, P2 cell, resonant converters, protection circuits, charger design and calculation of losses.

Text Books/Reference Books :

1. Valve-regulated Lead–Acid Batteries, D.A.J. Rand, P.T. Moseley, J. Garche and C.D. Parker, Elesevier, 2004
2. Energy Storage Systems in Electronics-New Trends in Electrochemical Technology, Tetsuya Osaka, Madhav Datta, CRC Press, 2000
3. Industrial Applications of Batteries from Cars to Aerospace and Energy Storage, M. Broussely, G. Pistoia, Elsevier, 2007.
4. Lithium Batteries – Science and Technology, G.A. Nazri and G. Pistoia, , Kluwer Academic Publishers, 2004.
5. Fuel Cell Systems Explained, James Larminie, Andrew Dicks, Wiley-Blackwell, 2nd edition, 2003

EE 412-10 Microwave Integrated Circuits	L T P	Credits

UNIT I

Active RF Component Modeling : Diode models, transistor models, large and small signal BJT and FET models, measurement of active devices, S-parameter device characterization.

UNIT II

Amplifier Design : Unilateral and non-unilateral design, one stage and multistage design low noise amplifiers high –power amplifiers, balanced amplifiers feedback. design examples, small-signal distributed amplifiers. Oscillator Design: Resonators, dielectric resonators, YIG resonators, varactor resonators, resonator measurements, two-port oscillator design, low-noise design, non-linear oscillator models.

UNIT III

Mixer Design : Diode mixer theory, single diode mixers, single-balanced mixers, double balanced mixers, FET mixer theory, balanced FET mixers, spectral mixer circuits, image rejection mixer, single side band modulator performance, simple sub harmonically pumped mixer circuit configuration.

UNIT IV

Filter Design : Filter design by the insertion loss method, filter scaling and transformations, low pass and high-pass filters using transmission line stubs, stepped-impedance low-pass filters, band pass filters using transmission line resonators.

UNIT V

MIC Design : Integrated microwave workstation approach, nonlinear tools, filed drivers design, designing non-linear circuits using the harmonic balanced method. programmable microwave tuning system, introduction to MMIC considering layout effects, microwave integrated circuit components.

Text Books/Reference Books :

1. Microwave circuits design using linear and nonlinear techniques, George.D.Vandeling, Anthony M.Pavis and Ulrich L.Rohde, John Wiley and Sons 1990.
2. Microwave Circuits and analysis and amplifier design, Samuel T. Liao, PHI, 1987.
3. Microwave and RF Design of Wireless Systems, Davis M. Pozar, John Wiley and Sons.
4. RF Circuit Design, Ludwig and Bretchko, Pearson Education.

EE 412-11 Energy Auditing, Conservation and Management	L T P	Credits

UNIT I

Basic Principles of Energy Audit : Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit

UNIT II

Energy management : Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manger, Qualities and functions, language, Questionnaire - check list for top management

UNIT III

Energy Efficient Motors : Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit

UNIT- IV: Power Factor Improvement, Lighting and Energy Instruments :

Power factor – methods of improvement , location of capacitors , Pf with non linear loads, effect of harmonics on p.f. , p.f motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers,lux meters, tongue testers ,application of PLC's

UNIT –V: Economic Aspects and Analysis :

Economic Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

Text Books/Reference Books :

1. Energy Management, Murphy W. R., Elsevier, 2003
2. Energy Management: A Comprehensive Guide to Reducing Costs by Efficient Energy Use, Paul W. O'Callaghan, McGraw-Hill ,1992
3. Energy-efficient Electric Motors: Selection and Applications,John C. Andreas, Marcel Dekker Inc,2nd edition,1992
4. Energy-Efficient Electric Motors, Ali Emadi, CRC Press, 3rd edition, 2004
5. Energy Management Handbook, Steve Doty, Wayne C. Turner, Fairmont Press,8th edition, 2012
6. Handbook of Energy Audits, Albert Thumann, Terry Niehus, William J. Younger, Fairmont Press,9th edition, December 2012
7. The Handbook of Lighting Surveys and Audits, John L. Fetters, CRC Press,1997
8. Recent Advances in Control and Management of Energy Systems, D.P.Sen Gupta, K.R.Padiyar, Indranil Sen, M.A. Pai, Interline Publishers, Bangalore, 1993

EE-413 Open Elective-II	L T P	Credits
	3 1 0	4

Open Elective-II
*EE 413-1 Database Management Systems
*EE 413-2 Operating System Design
EE 413-3 Optimal Control Theory
*EE 413-4 Active & Passive Network Synthesis
*EE 413-5 Computer Control of Processes
EE 413-6 Reliability Engineering
*EE 413-7 Artificial Intelligence and Expert Systems
*EE. 413-8 Digital System Design
*EE 413-9 Filter Design
*EE-413-10 VLSI Design
*EE 413-11 Antenna & Wave Propagation

EE-413-1 Data Base Management Systems	L T P	Credits

UNIT I

Introduction : An overview of database management system, database system vs file system, database system concept and architecture, data model schema and instances, data independence and database language and interfaces, data definitions language, DML, overall database structure.

UNIT II

Data Modeling using the Entity Relationship Model ER model concepts, notation for ER diagram, mapping constraints, keys, concepts of super key, candidate key, primary key, generalization, aggregation, reduction of ER diagrams to tables, extended ER model, relationship of higher degree. Relational data Model and Language:Relational data model concepts, integrity constraints, entity integrity, referential integrity, keys constraints, domain constraints, relational algebra, relational calculus, tuple and domain calculus.

UNIT III

Introduction to SQL : Characteristics of SQL, advantage of SQL, SQL data type and literals, types of SQL commands, SQL operators and their procedure, tables, views and indexes, queries and sub queries, aggregate functions, insert, update and delete operations, joins, unions, intersection, minus, cursors, triggers, procedures in SQL/PL SQL

UNIT IV

Data Base Design & Normalization : Functional dependencies, normal forms, first, second, third normal forms, BCNF, inclusion dependence, loss less join decompositions, normalization using FD, MVD, and JDs, alternative approaches to database design.Transaction Processing Concept: Transaction system, testing of serializability, serializability of schedules, conflict & view serializable schedule, recoverability, recovery from transaction failures, log based recovery, checkpoints, deadlock handling. Distributed Database: distributed data storage, concurrency control, directory system.

UNIT V

Concurrency Control Techniques : Concurrency control, locking techniques for concurrency control, time stamping protocols for concurrency control, validation based protocol, multiple granularity, multi version schemes, recovery with concurrent transaction, case study of Oracle.

Text Books/Reference Books :

1. An Introduction to Database Systems, C. J. Date, A. Kannan, S. Swamynathan, Pearson Education,8th edition, 2012
2. Database System Concepts,Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Mc Graw-Hill Higher Education, 6th edition, 2010
3. Fundamentals of Database Systems, Ramez Elmasri, Shamkant Navathe, Addison Wesley, 6th edition, 2010
4. Database Management Systems, A Leon, Tata McGraw Hill Education,2008
5. Database Management System, Arun Majumdar, Pritimoy Bhattacharyya, Mc Graw-Hill Education, 2001
6. Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke, McGraw-Hill Higher Education, 3rd edition, 2002.

EE-413-2 Operating System Design	L T P	Credits

UNIT I

Operating System – An Overview : Introduction to OS – Mainframe systems – Desktop systems – Multiprocessor systems – Distributed systems – Clustered systems – Real time systems – Handheld systems. Computer system operation – I/O structure – Storage structure –storage hierarchy – Hardware protection – Network structure. System components – Operating system services – System calls – System programs – System structure – Virtual machines – System design and implementation – System generation.

UNIT II

Process Management : Process concept – Process scheduling – Operating on processes – cooperating processes – inter process communication – communication in client – server systems. Threads – Overview – Multithreading models – Threading issues, Basics concepts – Scheduling criteria – Scheduling algorithms – Multiple – processor scheduling – real time scheduling – process scheduling models. The critical section problem – Synchronization hardware - Semaphores – Classic problems of synchronization – critical regions – Monitors - Atomic transactions. System model – Deadlock characterization – Methods for handling deadlocks – Deadlock prevention – Deadlock avoidance – Deadlock detection – Recovery from dead lock.

UNIT III

Storage Management : Background – swipping – contiguous memory allocation – Paging – Segmentation – Segmentation with paging. Background – Demand paging –
Process creation – Page replacement – allocation of frames – Thrashing,. File concept: Access methods – Directory structure – File system mounting – File sharing – Protection. File system structure - file system implementation – Directory implementation – Allocation methods – free – space management – Efficiency and performance – Recovery.

UNIT IV

I/O Systems : I/O hardware - Application I/O interface – Kernel I/O subsystem – Transforming I/O to hardware operations – Streams – Performance. Disk structure – Disk scheduling – Disk management – Swap-space management – RAID structure – Disk attachment – Stable - Storage implementation – Tertiary storage structure.

UNIT V

Distributed Systems : Background – Topology – Network types – Communication – communication protocols – Robustness – Design issues. Naming and transparency – Remote file access – Stateful versus stateless service – File replication. Event ordering – Mutual exclusion – Atomicity – Concurrency control – Deadlock handling – Election algorithms –Reaching agreement.

Text Books/Reference Books :

1. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons,8th edition, 2009
2. Operating Systems,Harvey M. Deitel, Paul J. Deitel, David R. Choffnes, Prentice Hall, 3rd edition, 2003
3. Modern Operating Systems, Tanenbaum Andrew S, Prentice-Hall, 3rd edition, 2009
4. Operating Systems: Internals and Design Principles, William Stallings, Pearson Education, 6th edition,2009

EE-413-3 Optimal Control Theory	L T P	Credits

UNIT I

Introduction : Statement of optimal control problem, problem formulation and forms of optimal control, selection of performance measures. necessary conditions for optimal control, Pontryagin's minimum principle, state inequality constraints, minimum time problem.

UNIT II

LQ Control Problems and Dynamic Programming : Linear optimal regulator problem, Matrix Riccatti equation and solution method, choice of weighting matrices, steady state properties of optimal regulator, linear tracking problem, LQG problem, computational procedure for solving optimal control problems, characteristics of dynamic programming solution, dynamic programming application to discrete and continuous systems, Hamilton Jacobi Bellman equation.

UNIT III

Numerical Techniques for Optimal Control : Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method, solution of Ricatti equation by negative exponential and interactive methods.

UNIT IV

Filtering and Estimation : Filtering, linear system and estimation, system noise smoothing and prediction, Gauss Markov discrete time model, estimation criteria, minimum variance estimation, least square estimation, recursive estimation.

UNIT V

Kalman Filter and Properties : Filter problem and properties, linear estimator property of Kalman Filter, time invariance and asymptotic stability of filters, time filtered estimates and signal to noise ratio improvement, extended Kalman Filter.

Text Books/Reference Books :

1. Optimal Control Theory: An Introduction, Donald E. Kirk, Dover Publications, 2012
2. Optimum Systems Control, Andrew P. Sage, Chelsea C. White, Prentice Hall, 2nd revised edition, 1977
3. Optimal Filtering, Brian D. O. Anderson, Sister John, Dover Publications Inc,2005
4. Digital and Kalman Filtering, S. M. Bozic, Butterworth-Heinemann Ltd, 2nd revised edition,1994

EE-413-4 Active and Passive Network Synthesis	L T P	Credits

UNIT I

Network Functions : Network function for one port and two port ,calculation of network functions for Ladder networks and general networks, poles and zero of network functions, restrictions on pole and zeros locations for driving point functions and for transfer functions. time domain behavior from poles and zero plot, stability of achieve.

UNIT II

Networks : Elements of reliability theory, sensitivity and stability, positive real function elementary synthesis procedures.

UNIT III

Synthesis of One Port Networks with Two Kinds of Elements : Properties of L- C immittance functions, synthesis of L-C Driving point impedances, properties of R-C impedances and R-L, admittances properties of R-L impedances and R-C admittances, synthesis of certain R-L-C functions.

UNIT IV

Passive Network Synthesis : Positive real function, driving point and transfer impedance function, necessary conditions for driving point and transfer function L-C network, synthesis of dissipative network, two terminal R-L and R-C networks.

UNIT V

Active Networks : State variable theory, operation of amplifier circuits, active RC synthesis, stability of active network, filter design.

Text Books/Reference Books :

1. Active Integrated Circuit Synthesis, Robert W. Newcomb, Prentice Hall, 1969
2. Network Analysis and Synthesis, Franklin F. Kuo, Wiley India Pvt Ltd,2nd edition, 2006
3. Fundamentals of Network Analysis & Synthesis, Behrouz Peikari, Jaico Publishing House, 1st edition, 2006

EE-413-5 Computer Control of Processes	L T P	Credits

UNIT I Introduction to Process Control :
Introduction to process control, basic control action ON /OFF, P, PI, PID, floating control and electronic controller, tuning, line diagram from process plant to computer system, loose coupled system and tight coupled system, communication media and bus.

UNIT II
Protocol and Architectures : Evolution of data networks, network architecture, Protocols, layered approach, OSI model, DoD model, hierarchical approach, local network technology, bus/tree topology, ring topology, medium access protocols, details of IEEE 802, X.25, datagram, HDLC standards.

UNIT III
Signals from Process Instrumentation : Signal conditioning for the control of computer, signal transmission, time division multiplexing, signal termination, impedance matching filtering, numerical filtering, correction for non-linearities, computer control system, CPU, relationship of word length to performance, peripheral devices.

UNIT IV
Programmable Logic Controllers : Evolution of PLC, sequential and programmable controllers, architecture, programming of PLC, relay logic and ladder logic, functional blocks, communication networks for PLC, field bus such as profi-bus, mod-bus etc.
UNIT-V: Distributed Control Systems: Evolution of DCS, architecture, local control unit, operator interface, engineering interface.

Text Books/Reference Books :

1. Instrument Engineers' Handbook Process Control, Liptak, Elsevier, 2010
2. Industrial Electronics: Applications for Programmable Controllers, Instrumentation & Process Control, and Electrical Machines & Motor, Thomas E. Kissell, Prentice Hall, 2nd edition, 1999
3. Computer - Based Industrial Control, Kant Krishna, PHI, 2nd edition 2010
4. Instrumentation for Process Measurement and Control, Norman A. Anderson, CRC Press, 3rd edition, 1997
5. Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Higher Education,4th edition, 2010
6. Data Communications and Networking, Behrouz Forouzan, McGraw-Hill,5th edition, 2012.

EE-413-6 Reliability Engineering	L T P	Credits

UNIT I
Basics of Probability theory & Distribution : Basic probability theory, rules for combining probabilities of events, Bernoulli's trials, probabilities density and distribution functions, binomial distribution,
expected value and standard deviation of binomial distribution. Network Modelling and Reliability Analysis: analysis of series, parallel, series-parallel networks, complex networks, decomposition method.

UNIT II
Reliability Functions and Markov Modelling : Reliability functions f(t), F(t), R(t), h(t) and their relationships, exponential distribution, expected value and standard deviation of exponential distribution, bath tub curve, reliability analysis of series parallel networks using exponential distribution, reliability measures MTTF, MTTR,MTBF. Markov chains, concept of stochastic transitional probability Matrix, evaluation of limiting state probabilities, Markov processes, one component repairable system, time dependent probability evaluation using Laplace transform approach, evaluation of limiting state probabilities using STPM, two component repairable models

UNIT III
Frequency & Duration Techniques : Frequency and duration concept, evaluation of frequency of encountering state, mean cycle time for one and two component repairable models, evaluation of cumulative
probability and cumulative frequency of encountering of merged states.

UNIT IV
Generation System Reliability Analysis : Reliability model of a generation system, recursive relation for unit addition and removal, load modeling, merging of generation load model, evaluation of transition rates for merged state model, cumulative probability, cumulative frequency of failure evaluation, LOLP, LOLE.

UNIT V
Composite Systems Reliability Analysis : Decompositions method, reliability indices, weather effects on transmission lines. Distribution System and Reliability Analysis: basic concepts, evaluation of basic and performance reliability indices of radial networks.

Text Books/Reference Books :

1. Power System Reliability Calculation, Roy Billinton, R.J. Ringlee, A.J. Wood, MIT Press, 1973
2. New Computational Methods in Power System Reliability, David Elmakias, Springer, 2008
3. Reliability Evaluation of Engineering Systems: Concepts and Techniques, Roy Billinton, Ronald N. Allan, Springer,2013
4. An Introduction to Reliability and Maintainability Engineering. Charles E. Ebeling, Mc Graw-Hill Education, 2000

EE 413-7 Artificial Intelligence and Expert Systems	L T P	Credits

UNIT I

Introduction : Approaches to intelligent control, architecture for intelligent control, symbolic reasoning system, rule based systems - the AI approach, knowledge representation, expert systems, artificial neural networks (ANN): concept of ANN and its basic mathematical model, McCulloch-Pitts neuron model, simple perception, Adaline and Madaline feed forward multilayer perceptron, learning and training the neural network, data processing: scaling, Fourier transformation, principal-component analysis and wavelet transformations, Hopfield network, self-organizing network and recurrent network, neural network based controller.

UNIT II

Genetic Algorithm : Basic concept of Genetic algorithm and detail algorithm steps, adjustment of free parameters, solution of typical control problems using genetic algorithm, concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems

UNIT III

Fuzzy Logic System : Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning, introduction to fuzzy logic modeling and control, fuzzification, inferencing and defuzzification, fuzzy knowledge and rule bases, fuzzy modeling and control schemes for nonlinear systems, self-organizing fuzzy logic control, fuzzy logic control for nonlinear time-delay systems.

UNIT IV

Applications : GA application to power system optimization problem, case studies: identification and control of linear and nonlinear dynamic systems using Matlab -neural network toolbox, stability Analysis of neural –network interconnection system, implementation of fuzzy logic controller using Matlab - fuzzy logic toolbox, stability analysis of fuzzy control systems.

UNIT V

Expert System: Need for expertise in decision models and expert systems, expert systems fundamentals, knowledge engineering, knowledge representation and inferencing, building expert systems, integrating expert systems and DSSs, strategies for implementing and maintaining management support systems, case studies, laboratory and filed projects.

Text Books/Reference Books :

1. Introduction to Artificial Neural Systems, Jacek M. Zurada, Jaico Publishing House, 1997
2. Neural Networks, Fuzzy Logic and Genetic Algorithms – Sudarshan K.Valluru,T.N.Rao, Jaico, 2009
3. C++ Neural Networks, & FuzzyLogic, Valluru B. Rao, Hayagriva V.Rao BPB Publications, 1996.
4. Artificial Intelligence application in Power System, M.E. E1. Hawary, Wiley-Blackwell , 1998
5. Artificial Neural Networks, Yegnanarayana B, PHI, 1998
6. Fuzzy Logic: With Engineering Applications,Timothy J. Ross, Wiley India Pvt Ltd,2nd edition, 2007
7. Genetic Algorithms in search, Optimization and Machine Learning, David E. Goldberg, Pearson Education India, 1st edition, 2008
8. Expert Systems: Principles and Programming, Riley, Vikas-Thomson Learning, 2002.

EE 413-8 Digital System Design	L T P	Credits

UNIT I

Overview of Digital System Design with Verilog HDL Evolution of CAD, emergence of HDLs, importance of HDLs, typical HDL-based design flow, hierarchical modeling concepts.

UNIT II

Gate-Level Modeling : Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Dataflow Modeling: continuous assignments, delay specification, expressions, operators, operands, operator types. Behavioral Modeling: Structured procedures, initial and always, blocking and non blocking statements, delay control, generate statement, event control, conditional statements, multi way branching, loops, sequential and parallel blocks, test vectors/test benches.

UNIT III

Tasks and Functions : Differences between tasks and functions, declaration, invocation, automatic tasks and functions. Useful Modeling Techniques: procedural continuous assignments, overriding parameters, conditional compilation and execution, useful system tasks, timing and delays, switch-level modeling, basics of user-defined primitives and PLI.

UNIT IV

Logic Synthesis with Verilog HDL : Introduction to logic synthesis, impact of logic synthesis, Verilog HDL constructs and operators for logic synthesis, synthesis design flow, verification of synthesized circuits, design partitioning.

UNIT V

Types of memory : SRAM, flash memory, PLA, PAL, PROM, EPROM, EEPROM, CPLDs, FPGAs: Design, Architecture and applications.

Text Books/Reference Books :

1. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, 2nd edition, Prentice-Hall.
2. Verilog Digital System Design: Register Transfer Level Synthesis, Testbench, and Verification, Zainalabedin Navabi, McGraw Hill Professional.

3. Advanced Digital Design with the Verilog HDL, Michael D. Ciletti, Prentice Hall, 2nd edition, 2010
4. Digital Logic and Computer Design, M. Morris Mano, PHI, 2002.
5. Fundamentals of Digital Circuits, A. Anand Kumar, PHI, 2006.
6. Digital Design Principles and Practice, John F. Wakerly, 3rd edition, Pearson Education.

EE 413-9 Filter Design	L T P	Credits

UNIT I

Basic Concepts : Nature of filter specification, filter design process, ideal low magnitude approximation, frequency transformation.

UNIT II

Passive Filter with Lumped Elements : General two port reactance network, filter circuits, design of ladder networks.

UNIT III

Active Building Blocks For Analog Filter Design : Ideal and real operational amplifiers, transconductance amplifiers, current feedback amplifiers, transresistance and other amplifier topologies, characteristic and their usages in realization of summers, integrators, gyrators and immittance converters.

UNIT IV

Biquad Filters Using Active Building Blocks : Single amplifier biquad, biquads using composite amplifiers, G/C based biquads, two-integrator loop topologies.

UNIT V

Higher Order Filters : Cascade and multiple loop feedback realization, LC ladder simulation by single flow graph and element substitution. Transconductance – C (Gm-C) based filters, switched capacitor filters.

Text Books/Reference Books :

1. Design of Analog Filter Passive Active RC and switched capacitor, R.Schaumann, M.S. Ghausi and Keneth Laker, PHI, 1990.
2. Design of Analog Filters R.Schaumann Mac. E.Van Valkenberg, Oxford University Press, 2001.

EE 413-10 VLSI Design	L T P	Credits

UNIT I

Introduction and Basic Electrical Properties : Introduction to IC Technology – MOS, PMOS, NMOS, CMOS and Bi CMOS technologies, oxidation, lithography, diffusion, ion implantation, metallisation, encapsulation, probe testing, integrated resistors and capacitors, basic electrical properties of MOS and BiCMOS Circuits:Ids-Vds relationships, MOS transistor threshold voltage, gm, gds, figure of merit ωo, pass transistor, NMOS inverter, various pull ups, CMOS inverter analysis and design, Bi-CMOS inverters.

UNIT II

VLSI Circuit Design Processes : VLSI design flow, MOS layers, stick diagrams, design rules and layout, 2 μ m CMOS design rules for wires, contacts and transistors layout diagrams for NMOS and CMOS inverters and gates, scaling of MOS circuits, limitations of scaling. Gate Level Design : logic Gates and other complex gates, switch logic, alternate gate circuits, basic circuit concepts, sheet resistance and its concept to MOS, area capacitance units, calculations, s - t - delays, driving large capacitive loads, wiring capacitances, fan-in and fan-out, choice of layers

UNIT III

Subsystem Design : Subsystem design, shifters, adders, ALUs, multipliers, parity generators, comparators, zero/ one detectors, counters, high density memory elements. Semiconductor Integrated Circuit Design : PLAs, FPGAs, CPLDs, standard cells, programmable array logic, design approach.

UNIT IV

VHDL Synthesis : VHDL synthesis, circuit design flow, circuit synthesis, simulation, layout, design capture tools, design verification tools, test principles.

UNIT V

CMOS Testing : CMOS testing, need for testing, test principles, design strategies for test, chip-level test techniques, system-level test techniques, layout design for improved testability.

Text Books/Reference Books :

1. Essentials of VLSI Circuits and Systems, Pucknell Douglas A, Eshraghian Kamran, Eshraghian Sholeh, PHI, 1st edition, 2005.
2. Principles of CMOS VLSI Design: A Systems Perspective, Neil H.E. West, Kamran Eshraghian, Addison Wesley, 2nd edition, 1993
3. Chip Design for Submicron VLSI: CMOS Layout & Simulation,Cengage Learning,2006
4. Introduction to VLSI Circuits and Systems, John .P. Uyemura, JohnWiley, 2003.
5. Digital Integrated Circuits ,John M. Rabaey, PHI, 1997.
6. Modern VLSI Design, Wayne Wolf, Pearson Education, 3rd edition, 1997.

EE 413-11 Antenna and Wave Propagation	L T P	Credits

UNIT I

Antenna Principles : Potential functions & electromagnetic field, current elements, radiation from monopole & half wave dipole, power radiated by current element, radiation

resistance, network theorems directional properties of dipole antenna, antenna gain, effective area, antenna terminal impedance, practical antennas and methods of excitation, antenna temperature and signal to noise ratio.

UNIT II

Antenna Arrays Two element array, horizontal patterns in broadcast arrays, linear arrays, multiplication of patterns, effect of the earth on vertical patterns, binomial array.

UNIT III

Wave Propagation : Modes of propagation, plane earth reflection, space wave and surface wave, reflection and refraction waves by the ionosphere, tropospheric wave, ionosphere wave propagation, virtual height , MUF critical frequency, skip distance, duct propagation, space wave.

UNIT IV

Practical Antennas : VLF and LF transmitting antennas, effect of antenna height, field of short dipole, electric field of small loop antenna, directivity of circular loop antenna with uniform current, directivity of circular loop antenna with uniform current, Yagi-Uda array: square corner Yagi-Uda hybrid, circular polarization, rhombic antenna weight and leg length, parabolic reflectors properties, comparison with corner reflectors, horn antenna: length and aperture, introduction to turstile antenna, effect of ground on antenna performance.

UNIT V

Broadband Antenna : Frequency independent concept, Rumsey's principle, frequency independent planar log spiral antenna, frequency independent conical spiral antenna.

Text Books/Reference Books :

1. Antennas for All Applications, John D. Kraus, Ronald J. Marhefka, TMH, 3rd edition, 2003.
2. Electromagnetic Waves and Radiating Systems , E.C. Jordan and K.G. Balmain, PHI, 2nd edition,2000.
3. Antenna Theory,C.A. Balanis, John Wiley & Sons, 2nd edition, 2001.
4. Antennas, John D. Kraus, McGraw-Hill, 2nd edition, 1988.
5. Electronic and Radio Engineering, F.E. Terman, McGraw-Hill, 4th edition, 1955.

EE-414 DSP Lab	L T P	Credits
	0 0 3	3

Based on the course work corresponding to EE – 411

EE-415 Elective-II Lab	L T P	Credits
	0 0 3	3

Based on course work corresponding EE – 415

EE-416 Major Project-II	L T P	Credits
	0 0 10	10

Based on the course work corresponding to EE – 412

EE – 417 Seminar/Report	L T P	Credits
	0 0 2	2