CS1001 FOUNDATIONS OF COMPUTING

Pre-requisite: NIL

L	T	P	C
2	0	0	2

Module 1 : Logic (7 hours)

Propositional logic, implications and inference, equivalence, truth tables. Normal forms. duality, minimization. logic gates and combinational Circuit design, Introduction to first order logic.

Module 2 : Sets and Relational structures (7 hours)

Sets, relations, functions, transitive closures, partial order, lattices, boolean lattices, boolean algebras.

Module 3 Proof Techniques and Recursion (7 hours)

Methods of proof using Induction, deduction proofs and contradiction. Recursion and recursive definitions.
Writing recursive programs.

Module 4 Graphs: (7 hours)

Basic definitions, trees, paths, cycles and elementary properties.

References:

1. E. Mendelson, Shaum's outline on boolean algebra and switching circuits, McGraw Hill, 1970.

2. B. Kolman, R. Busby, R. C. Ross, Discrete Mathematics, Pearson (6/e), 2008.

CY1001: Chemistry

Pre-requisites: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1: Chemical Bonding (8 hours)

Quantum mechanical methods in chemical bonding: molecular orbital theory, symmetry of molecular orbitals, MOs for homonuclear diatomic molecules, application of MO theory to heteronuclear diatomics, valence bond theory, hybridization, hybridization involving d orbitals, conjugated molecules, Huckel molecular orbital theory of conjugated systems, metallic bonding, band theory .

Module2: Spectroscopy (14 hours)

General features of spectroscopy, interaction of radiation with matter, theory and application of rotational, vibrational, Raman, electronic, mass, NMR, fluorescence and photoelectron spectroscopy.

Module 3: Transition Metal Chemistry (12 hours)

Bonding in transition metal complexes: coordination compounds, crystal field theory, octahedral, tetrahedral and square planar complexes, crystal field stabilization energies, Jahn-Teller theorem, spectral and magnetic properties. Bio-Inorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin-cooperativity; Bohr effect, Hill coefficient, oxy and deoxy haemoglobin, reversible binding of oxygen.

Module 4: Aromaticity (8 hours)

Electron delocalization, resonance and aromaticity; molecular orbital description of aromaticity and anti-aromaticity, annulenes; ring current, NMR as a tool, diamagnetic anisotropy; aromatic electrophilic substitutions, aromatic nucleophilic substitutions, benzyne; reaction mechanisms, reactivity and orientation.

Text Books:

1. J. E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, Harper Collins, New York 1997.
2. F. A. Cotton and G Wilkinson, *Advanced Inorganic Chemistry*, 5th Edition, Wiley Interscience, New York, 1988.
3. J. D. Lee, *Concise Inorganic Chemistry*, Chapman & Hall, London, 1996.
4. W. L. Jolly, *Modern Inorganic Chemistry*, McGraw-Hill International, 2nd Edition, New York, 1991.
5. R. T. Morrison and R N Boyd, *Organic Chemistry*, 6th Edition, Prentice Hall, New Delhi, 1999.
6. P. Bruice, *Organic Chemistry*, 3rd Edition, Prentice Hall, New Delhi , 2001.
7. F. Carey, *Organic Chemistry*, 5th Edition, McGraw Hill Publishers, Boston, 2003.
8. J. Mc Murray, *Organic Chemistry*, 5th Edition, Brooks/ Cole Publishing Co, Monterey, 2000.
9. C.N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, McGraw-Hill, International, UK, 1995.
10. William Kemp, *Organic Spectroscopy*, 3rd edition, Palgrave, New York, 2005.

11. R.M. Silverstein, F.X. Webster and D.J. Kiemle, *Spectrometric Identification of Organic* C*ompounds***,** 7th edition**,** John-Wiley and Sons, New York, 2005.
12. D. L. Pavia, GM. Lampman, GS. Kriz and J.R Vyvyan, I, *Spectroscopy*, Cengage Learning India Pvt. Ltd, New Delhi, 2007.
13. B. R.Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing CO. Delhi, 2008.
14. P.W. Atkins, *Physical Chemistry*, 6th Edition, Oxford University Press, Oxford, 1998.

CY1094: Chemistry Laboratory

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total Hours: 28

Potentiometric and conductometric titrations, complexometric and iodimetric estimations, polarimetry, determination of pH, single step organic / inorganic preparations, colorimetry, determination of eutectic point.

References:

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, *Advanced Practical Physical Chemistry*, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, *Vogel's Text Book of Practical Organic Chemistry*, Longman and Scientific Technical, New York, 1989.

EC1001 INTRODUCTION TO ELECTRONICS ENGINEERING

Module 1: Basics of Electronics: Semiconductors, Band structure of Silicon, doping, PN junctions, MOSFET, simple inverter configurations, large scale integration concepts.

[7 hours]

Module 2: Signal Processing basics: Filtering, sampling, simple analog and digital filter configurations.

[7 hours]

Module 3: Communication basics: Signals and noise, ideas of AM and FM, PCM, noise immunity.

[7 hours]

Module 4: Basics of linear circuit design: Transfer function, speed and bandwidth, superposition of signals and noise, signal-to-noise ratio.

[7 hours]

Reference:

1. Millman & Halkias: Electronic Devices & Circuits, MGH, 2007
2. George Kennedy: Electronic Communication Systems, MGH, 1992
3. B P Lathi: Signal Processing & Linear Systems, Oxford University Press, 2000

EE1001 INTRODUCTION TO ELECTRICAL ENGINEERING

Pre-requisites: None

L	T	P	C
2	0	0	2

Module 1 : Introduction to Electrical Engineering (7 hrs)

Introduction to Engineering Profession, History of EE and milestones, Professional ethics, Professional organisations in the field of EE, about standards and certification of EE equipment and concerned organisations in the country, codes of practice in EE.

Structure and components of an Electrical Energy System – Generation, Transmission, Distribution and Utilisation overview – DC power versus AC power – DC transmission versus AC transmission – common voltage levels – major components of residential , commercial and industrial loads – guaranteed voltage and frequency values – Tariff structures – study of tariff structure of local Electrical utility (KSEB)

Brief introduction to various renewable energy sources

Module 2 : Batteries and Battery Charging (5 hrs)

Principle of operation of Lead-acid Batteries, AH rating, available capacity at different discharge rates, types of lead-acid batteries, different factors that affect battery life, abnormal conditions during charging and discharging, high discharge versus deep discharge, desirable charging profile, energy efficiency, float voltage, trickle charge current, need to avoid over-charging, constant current – constant voltage charging algorithm.

Different ways to charge a Lead-acid battery : (i) Capacitor + diode system (ii) full-wave or full-bridge rectifier with ac side choke (iii) full-wave or full-bridge rectifier with dc side resistor – qualitative description of more precise battery charging systems.

Areas of application of Lead-acid batteries and application requirements – in UPS, DG Sets cranking, Automobiles, Emergency lamps, Solar Power Systems etc.

Ni-Cd batteries and their charging, Lithium batteries and charging.

Module 3 : Analysis of Circuits with Dependent Sources (8 hrs)

Linear Dependent sources : VCVS, VCCS, CCVS and CCCS - node analysis and mesh analysis of circuits containing resistors, independent sources and linear dependent sources - effect of dependent sources on the symmetry of nodal admittance matrix and mesh impedance matrix - determination of Thevenin's and Norton's equivalent for circuits containing dependent sources

Dependent source equivalent circuits for coupled coils – a.c steady-state analyis of circuits containing coupled coils – the perfectly coupled two-winding transformer and the ideal two-winding transformer

Module 4 : Study of three-phase balanced and unbalanced circuits (8 hrs)

Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem for a.c circuits - Polyphase working - 3 phase a.c systems - balanced system - phase sequence - Star Delta Transformation Theorem - Balanced 3 phase a.c source supplying balanced 3 phase star connected and delta connected loads - Three phase loads with mutual coupling between phases - 3 wire and 4 wire systems - neutral shift - neutral current - active power, reactive power, complex power, apparent power and power factor in balanced and unbalanced three phase systems -Measurement of Power in Balanced and Unbalanced Systems.

(a) Text books :

1. 'Rechargeable Batteries Applications Handbook', Technical Marketing Staff of Gates Energy Products, BPB Publications, 1994
2. 'Electric Circuits & Networks' , Suresh Kumar K.S, Pearson Education, 2009
3. 'Engineering Circuit Analysis', Hayt & Kemmerly, 6th Edition, TMH, 2003

(b) Reference :

National Electrical Code, ISI, 1985

MA1001 - MATHEMATICS – I

L	T	P	C
3	1	0	3

Module I: Preliminary Calculus & Infinite Series (9L + 3T)

Preliminary Calculus : Partial differentiation, Total differential and total derivative, Exact differentials, Chain rule, Change of variables, Minima and Maxima of functions of two or more variables.

Infinite Series : Notion of convergence and divergence of infinite series, Ratio test, Comparison test, Raabe's test, Root test, Series of positive and negative terms, Idea of absolute convergence, Taylor's and Maclaurin's series.

Module II: Differential Equations (13L + 4T)

First order ordinary differential equations: Methods of solution, Existence and uniqueness of solution, Orthogonal Trajectories, Applications of first order differential equations.

Linear second order equations: Homogeneous linear equations with constant coefficients, fundamental system of solutions, Existence and uniqueness conditions, Wronskian, Non homogeneous equations, Methods of Solutions, Applications.

Module III: Fourier Analysis (10 L+ 3T)

Periodic functions : Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansions, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transforms, Fourier Transforms.

Module IV: Laplace Transforms (11L + 3T)

Gamma functions and Beta functions, Definition and Properties. Laplace Transforms, Inverse Laplace Transforms, shifting Theorem, Transforms of derivatives and integrals, Solution of differential Equations, Differentiation and Integration of Transforms, Convolution, Unit step function, Second shifting Theorem, Laplace Transform of Periodic functions.

Text Book:

Kreyszig E, 'Advanced Engineering Mathematics' 8th Edition, John Wiley & Sons New York, (1999)

Reference Books:

1. Piskunov, 'Differential and Integral Calculus, MIR Publishers, Moscow (1974).

2. Wylie C. R. & Barret L. C 'Advanced Engineering Mathematics' 6th Edition, Mc Graw Hill, New York, (1995).

3. Thomas G. B. 'Calculus and Analytic Geometry' Addison Wesley, London (1998).

MA1002 - MATHEMATICS II

L	T	P	C
3	1	0	3

Module I **(11 L + 3T)**

Linear Algebra I: Systems of Linear Equations, Gauss' elimination, Rank of a matrix, Linear independence, Solutions of linear systems: existence, uniqueness, general form. Vector spaces, Subspaces, Basis and Dimension, Inner product spaces, Gram-Schmidt orthogonalization, Linear Transformations.

Module II **(11 L+ 3T)**

Linear Algebra II: Eigen values and Eigen vectors of a matrix, Some applications of Eigen value problems, Cayley-Hamilton Theorem, Quadratic forms, Complex matrices, Similarity of matrices, Basis of Eigen vectors – Diagonalization.

Module III **(10L+3T)**

Vector Calculus I: Vector and Scalar functions and fields, Derivatives, Curves, Tangents, Arc length, Curvature, Gradient of a Scalar Field, Directional derivative, Divergence of a vector field, Curl of a Vector field.

Module IV **(11 L+4T)**

Vector Calculus II: Line Integrals, Line Integrals independent of path, Double integrals, Surface integrals, Triple Integrals, Verification and simple applications of Green's Theorem, Gauss' Divergence Theorem and Stoke's Theorem.

Text Book:

Kreyzig E, Advanced Engineering Mathematics, 8th Edn, John Wiley & Sons, New York (1999).

Reference Books:

1. Wylie C. R & Barrret L. C, Advanced Engineering Mathematics, 6th Edn, Mc Graw Hill, New York (1995).

2. Hoffman K & Kunze R, Linear Algebra, Prentice Hall of India, New Delhi (1971).

MS1001 PROFESSIONAL COMMUNICATION

L	T	P	C
3	0	0	3

Module 1 (11 hours)

Verbal Communication: received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

Module 2 (9 hours)

Reading Comprehension: skimming and scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing.

Module 3 (11 hours)

Written Communication: note making and note taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment.

Module 4 (11 hours)

Short essays: description and argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

Text Books

1. Adrian Doff and Christopher Jones: ***Language in Use*** – Upper intermediate, self-study workbook and classroom book. (Cambridge University Press)[2000]
2. Sarah Freeman: ***Written Communication*** (Orient Longman)[1978]
3. Mark Ibbotson: ***Cambridge English for Engineering*** (Cambridge University Press) November 2008
4. T Balasubramanian: ***English Phonetics for Indian Students: A Workbook*** (Macmillan publishers India) 2000

Reference

1. Chris Mounsey: ***Essays and Dissertation*** (Oxford University Press) February 2005.
2. Sidney Greenbaum: ***The Oxford English Grammar*** (Oxford University Press) March 2005
3. Krishna Mohan and Meera Banerji: ***Developing Communication Skills*** (Mac Millan india Ltd)[2000]
4. Krishna Mohan and Meenakshi Raman: ***Effective English Communication*** (Tata Mc-Graw Hill)[2000]

PH1001 PHYSICS

Module 1 – Theory of Relativity (6 hours)
Frames of reference, Galilean Relativity, Michelson-Morley experiment, postulates of Special Theory of Relativity, Lorentz transformations, simultaneity, length contraction, time dilation, velocity addition, Doppler effect for light, relativistic mass and dynamics, mass energy relations, massless particles, Description of General Theory of Relativity.

Module 2 - Quantum Mechanics (10 hours)
Dual nature of matter, properties of matter waves, wave packets, uncertainty principle, formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy – bound states, application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling, Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope.

Module 3 – Statistical Physics (12 hours)
Temperature, microstates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, applications – Lasers and Masers, Quantum distributions – many particle systems, wave functions, indistinguishable particles, Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, Bose-Einstein condensation, Specific heat of a solid, free electron gas and other applications.

Module 4 – Applications to Solids (14 hours)
Band theory of solids, conductors, semi-conductors and insulators, metals – Drude model and conductivity, electron wave functions in crystal lattices, E-k diagrams, band gaps, effective mass, semiconductors, Fermi energy, doping of semiconductor, conductivity and mobility of electrons, Hall effect, Fundamentals of mesoscopic physics and nano technology: size effects, interference effect, quantum confinement and Coulomb blockade. Quantum wells, wires, dots, nanotubes, semiconductor nano materials, Magnetism: dipole moments, paramagnetism, Curie's law, magnetization and hysterisis, Ferromagnetism and Anti-Ferromagnetism.

Text Books
1. *Modern Physics for Scientists and Engineers*, J. R. Taylor, C.D. Zafiratos and M. A. Dubson, 2nd Ed., Pearson (2007)
2. *Concepts of Modern Physics* Arthur Beiser, 6th Ed., Tata Mc Graw –Hill Publication (2009)

References
1. *Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle,* Robert Eisberg and Robert Resnick, 2nd Ed., John Wiley(2006)
2. *Solid state Devices*, B. G. Streetman, 5th Ed., Pearson (2006)

PH1091 PHYSICS LAB

L	T	P	C
0	0	2	1

LIST OF EXPERIMENTS

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Milliken oil drop experiment
10. Determination of Magnetic Field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of Magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field

NOTE: Any 8 experiments have to be done.

Reference:

1. *Experiments in Engineering physics*, Avadhanulu, Dani and Pokley, S. Chand & Company ltd (2002).
2. *Experiments in Modern Physics*, A.C. Melissinos, J. Napolitano, Academic Press (2003)
3. *Practical physics*, S.L. Gupta and V. Kumar, Pragathi Prakash (2005)

ZZ1001 ENGINEERING MECHANICS

L	T	P	C
3	0	0	3

Part A--Statics

MODULE 1 (12 hours)

Fundamentals of mechanics: idealisations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics.

Important vector quantities: Position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.

Equivalent force systems: Translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems.

Equations of equilibrium: Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

MODULE 2 (10 hours)

Applications of Equations Equilibrium: Trusses: solution of simple trusses, method of joints, method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems.

Properties of surfaces: First moment, centroid, second moments and the product of a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes, concept of second order tensor transformation.

Part B—Dynamics

MODULE 3 (10 hours)

Kinematics of a particle: Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of cylindrical coordinates, simple kinematical relations and applications.

Particle dynamics: Introduction, rectangular coordinates, rectilinear translation, Newton’s law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton’s law for cylindrical coordinates.

MODULE 4 (10 hours)

Energy and momentum methods for a particle: Analysis for a single particle, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, Linear momentum, impulse and momentum relations, moment of momentum.

Vibrations: Single degree of freedom systems, free vibration, undamped and damped, forced vibration, sinusoidal loading, introduction to multi degree of freedom systems, illustration using two degree-of-freedom systems.

Text Book

I. H. Shames, Engineering Mechanics—Statics and Dynamics, 4th Edition, Prentice Hall of India, 1996.

Reference Books

1. F.P. Beer and E.R. Johnston, *Vector Mechanics for Engineers – Statics*, McGraw Hill Book Company, 2000.
2. J.L. Meriam and L.G. Kraige, *Engineering Mechanics – Statics*, John Wiley & Sons, 2002.

ZZ1002 ENGINEERING GRAPHICS

L	T	D	C
2	0	3	3

Module 1 **(4Lecture+6drawing hours)**

Introduction to Engineering Graphics – Drawing instruments and their use – Different types of lines - Lettering & dimensioning – Familiarization with current Indian Standard Code of Practice for Engineering Drawing.
Scales, Plain scales, Diagonal scales, Vernier scales.
Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections – Projection of points in different coordinates – Projections of lines inclined to one of the reference planes

Module II

Projections of lines inclined to both the planes – True lengths of the lines and their angles of inclination with the reference planes – Traces of lines. **(4Lecture+6 drawing hours)**
Projection of plane lamina of geometric shapes inclined to one of the reference planes – inclined to both the planes, Traces of planes **(2Lecture+3 drawing hours)**
Projections on auxiliary planes **(2 lecture +3 drawing hours)**

Module III

Projections of polyhedra and solids of revolution, projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane – Projections with the axis inclined to one of the planes. Projections of solids with axis inclined to both the planes – Projections of spheres and combination of solids. **(4Lecture+6 drawing hours)**

Module IV

Sections of solids by planes perpendicular to at least one of the reference planes – True shapes of sections. **(2 lectures, 3 drawing hours)**
Developments, development of the lateral surface of regular solids like, prisms, pyramids, cylinders, cones and spheres, development of truncated solids **(2 lectures +3 drawing hours)**
Isometric projection – Isometric scale – Isometric views – Isometric projection of prisms, pyramids, cylinders, cones, spheres and solids made by combination of the above. **(2 lectures +6 drawing hours)**

Text book

Bhatt N. D**,** Elementary Engineering Drawing, Charotar Publishing House, Anand, 2002

References

1. Narayana K L & Kannaiah P, Engineering Graphics, Tata McGraw Hill, New Delhi, 1992
2. Luzadder W J, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi, 2001
3. Thomas E French & Charkes J V, Engineering Drawing & Graphing Technology, McGraw Hill Book Co, New York, 1993
4. Venugopal K, Engineering Drawing & Graphics, New Age International Pvt. Ltd., New Delhi, 1994

ZZ1003 BASIC ELECTRICAL SCIENCES

Pre-requisites: None

L	T	P	C
3	0	0	3

Module – 1 (11 Hours)

Two Terminal Element Relationships

Inductance - Faraday's Law of Electromagnetic Induction-Lenz's Law -Self and Mutual Inductance-Inductances in Series and Parallel-Mutual Flux and Leakage Flux-Coefficient of Coupling-Dot Convention-Cumulative and Differential Connection of Coupled Coils-

Capacitance - Electrostatics-Capacitance-Parallel Plate Capacitor-Capacitors in series and parallel- Energy Stored in Electrostatic Fields-.

v-i relationship for Inductance and Capacitance - v-i relationship for Independent Voltage and Current Sources –

Magnetic Circuits

MMF, Magnetic Flux, Reluctance- Energy Stored in a Magnetic Field-Solution of Magnetic Circuits.

Analysis of Resistive Circuits

Solution of resistive circuits with independent sources-

Node Analysis and Mesh Analysis-Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices-Source Transformation-

Circuit Theorems - Superposition Theorem-Thevenin's Theorem and Norton's Theorem- Maximum Power Transfer Theorem

Module – 2 (10 Hours)

Single Phase AC Circuits

Alternating Quantities- Average Value - Effective Value - Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms - Phasor representation of sinusoidal quantities - phase difference - Addition and subtraction of sinusoids - Symbolic Representation: Cartesian, Polar and Exponential forms-

Analysis of a.c circuits R, RL, RC, RLC circuits using phasor concept - Concept of impedance, admittance, conductance and susceptance –

Power in single phase circuits – instantaneous power – average power – active power – reactive power – apparent power – power factor – complex power – Solution of series, parallel and series-parallel a.c circuits-

Module - 3 (14 hrs)

Introductory Analog Electronics

Semiconductor Diode: Principle, Characteristics - Applications: Rectifier Circuits -Zener Diode, LED, Photo diode, IR diode

Bipolar Junction Transistor: Principle, Operation, Characteristics (CB, CE, CC)

Principle of working of CE, CB and CC amplifiers, quantitative relations for midband operation, input and output resistance levels – qualitative coverage on bandwidth - cascading considerations.

Introductory Digital Electronics

Transistor as a switch – switching delays, inverter operation

Digital Electronics : Number Systems and Conversions- Logic Gates and Truth Tables – Boolean Algebra – Basic canonical realizations of combinatorial circuits.

Standard Combinatorial Circuit SSI and MSI packages (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders etc)

MUX-based and ROM-based implementation of combinatorial circuits.

Module - 4 (7 hours)

Measuring instruments

Basics of electronic/digital voltmeter, ammeter, multimeter, wattmeter and energy meter. Measurement of Voltage, Current and Resistance. Introduction to Cathode Ray Oscilloscope - CRT, Block diagram of CRO

(a) Text Books :

1. Electric Circuits, James W Nilsson and Susan A Riedel, Pearson, 8th Edn, 2002
2. Electronic Devices and Circuit Theory, Robert L Boylestead & L Nashelsky, Pearson, 9th Edition, 2007
3. Digital Design , Morris Mano , PHI, 3rd Edition, 2005
4. Golding & Widdis, Electrical Measurements an Measuring Instruments;- Wheeler Publishers 5th edition, 1999.
5. Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 1997
6. A.K. Sawhney: A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co,16th Edition, 2006

(b) Reference Books :

1. Electric Circuits & Networks, Suresh Kumar K.S, Pearson Education, 2009
2. Microelectronics, Adel S Zedra and Kennath C Smith, Oxford University Press, 2004

ZZ1004 COMPUTER PROGRAMMING

Pre-requisite: NIL

L	T	P	C
2	0	0	2

Module 1 (7 Hours)

Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic, relational and logical operators – Assignment operator and expressions – conditional expressions – precedence and order of evaluation.

Control Flow: Statements and blocks – if-else, switch, while, for and do-while statements – break and continue statements, goto and labels.

Module 2 (7 Hours)

Functions and Program structure: Basics of functions, Parameter passing – scope rules - recursion.

Module 3 (7 Hours)

Pointers and Arrays: Single and multidimensional arrays - Pointers and arrays – address arithmetic - Passing pointers to functions.

Module 4 (7 Hours)

Structures and Unions: Basics of structures, Structures and functions – Arrays of Structures – Pointers to structures – self referential structures – Type definitions – Unions.

Input and Output: Standard input and output – Formatted output – variable length argument list – file access.

Text Book:

1. B. W. Kernighan and D. M. Ritchie, *The C Programming Language* (2/e), Prentice Hall, 1988.

References:

1. B.S. GottFried, *Schaum's Outline of Programming with C*(2/e), McGraw-Hill, 1996.
2. *C. L. Tondo and S. E. Gimpel, The* C Answer Book(2/e), Prentice Hall, 1988.
3. B. W. Kernighan, The Practice of Programming, Addison-Wesley, 1999.

ZZU1091 WORKSHOP PRACTICE I

L	T	P	C
0	0	3	2

Syllabus for Electrical & Electronics Engineering Workshop (4 weeks)

Four exercises from the following list of Exercises are to be carried out.

1. a. Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.
   b. Wiring of one lamp controlled by one switch.

2. a. Study of Electric shock phenomenon, precautions, preventions; Earthing
   b. Wiring of one lamp controlled by two SPDT Switch and one 3 pin plug socket independently.

3. a. Familiarization of types of Fuse, MCB, ELCB etc.
   b. Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.

4. a. Study of estimation and costing of wiring
   b. Domestic appliance – Wiring, Control and maintenance: Mixer machine, Electric Iron, fan motor, pump motor, Battery etc.

5. a. Familiarization of electronic components colour code , multimeters.
   b. Bread board assembling - Common emitter amplifier

6. a. Study of soldering components, solders, tools, heat sink.
   b. Bread board assembling – phase shift oscillator

7. a. Soldering practice - Common emitter amplifier
   b. Soldering practice - Inverting amplifier circuit

8. a. Study of estimation and costing of soldering –PCB: 3 phase connections
   b. Domestic appliances – Wiring PCB, control, Identification of fault: Electronic Ballast, fan regulator, inverter, UPS etc.

Reference:

1. K B Raina & S K Bhattacharya: Electrical Design Estimating and costing, New Age International Publishers, New Delhi, 2005
Uppal S. L., Electrical Wiring & Estimating, Khanna Publishers---5th edition, 2003

2. John H. Watt, Terrell Croft :American Electricians' Handbook: A Reference Book for the Practical Electrical Man - McGraw-Hill, 2002

3. G. Randy Slone - Tab Electronics Guide to Understanding Electricity and Electronics, Mc-GrawHill, 2000

4. Jerry C Whitaker - The Resource Handbook of Electronics, CRC Press-2001

ZZ1092 WORKSHOP PRACTICE II
(Eight classes of 3 hour duration each)

L	T	P	C
-	-	3	2

The course is intended to expose the student to the manufacturing processes through hands on training in the sections of Central Workshop. After the course, the student acquires the skill in using various tools, measuring devices, and learns the properties of different materials at varying conditions.

1) Carpentry: Study of tools and joints – plaining, chiseling, marking and sawing practice, one typical joint- Tee halving/Mortise and Tenon/ Dovetail

2) Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints- one simple exercise of single V joint for welding exercise.

3) Welding: Study of arc and gas welding, accessories, joint preparation, Exercise of a single V joint

4) Smithy: Study of tools, forging of square or hexagonal prism/ chisel/bolt

5) Foundry: Study of tools, sand preparation, moulding practice.

6) Sheet Metal work: Study of tools, selection of different gauge sheets, types of joints, fabrication of a tray or a funnel

7) Plumbing Practice: Study of tools, study of pipe fittings, pipe joints, cutting, and threading

8) Lathe Exercise: Study of the basic lathe operations, a simple step turning exercise.

References

1) Chapman W.A.J., Workshop Technology. Parts 1 & 2, 4th Edition, Viva Books P. Ltd., New Delhi, 2002
2) Hajra Choudhury.Workshop Technology Vol 1 & 2, Media Promoters & Publishers P.Ltd, Bombay, 2004
3) Welding Handbook. Miami, American Welding Society, 2000
4) Metals Handbook. Vol 6, Welding, Brazing & Soldering. Metals Park, Ohio, American Society of Metals, 1998
5) Serope Kalpakjian. Manufacturing Engineering & Technology. Pearson Steven R. Schmid Education (Asia) Inc., Delhi, 2002.
6) Anderson J., Shop Theory. Tata McGraw Hill, New Delhi, 2002
7) Olson D.W., Wood and Wood working. Prentice Hall India. 1992
8) Douglass J.H., Wood Working with Machines. McKnight &McKnight Pub. Co. Illinois, 1995
9) Tuplin W.A., Modern Engineering Workshop Practice Odhams Press, 1996
10) P.L. Jain. Principles of Foundry Technology. 4th Edition, Tata McGraw Hill, 2008.
11) R.K.Singal, Mridul Singal, Rishi Sringal. Basic Mechanical Engineering. 2007

SEMESTER III

Sl. No	Code	Title	L	T	P	C	Category
1	MA2001	Mathematics – III	3	1	-	3	BS
2	EE2001	Signals & Systems	3	-	-	3	PT
3	EE2002	Logic Design	3	-	-	3	PT
4	EE2003	Electrical Measurements	3	-	-	3	PT
5	EE2004	Basic Electronic Circuits	3	-	-	3	PT
6	EE2090	Basic Electrical Engineering Lab	-	-	3	2	PT
7	EE2091	Electronics Lab - I	-	-	3	2	PT
			15	**1**	**6**	**19**	

BRIEF SYLLABI

EE2001 SIGNALS & SYSTEMS

Pre-requisites: None

L	T	P	C
3	0	0	3

System as interconnection of elements - Signal definition – Size of a signal - Classification of signals – Basic signal operations – Linearity of system elements – element relation – superposition principle – Time-invariance - Bilateral versus unilateral elements -Formulation of differential equation for first order systems – need for initial condition specification - Source-free response of first order systems – Complete Solution for step/impulse/sinusoid inputs – First order mechanical system impulse and step response - zero-input response and zero-state response – relation between them to natural response and transient response – superposition principle as applied to various response components – Concept of steady-state – DC steady-state – Sinusoidal steady-state in first order systems - sinusoidal steady-state frequency response function of first order systems – periodic steady-state in first order systems -Time-domain analysis of second-order systems –undamped and weakly damped spring-mass system and LC system – Q factor versus rate of decay in stored energy in a weakly damped system - time-domain specifications for a second order system -Time-domain analysis of higher order systems –Convolution Integral – Properties of systems – linearity, time-invariance, causality and stability in terms of impulse response – Zero-state output of an LTI System for complex exponential input – condition of 'dominance' - eigen function — system function H(s) of a n^{th} order LTI system - Signal Expansion in terms of e^{st} kind of signals – Fourier Series -Frequency Response Function of a LTI System - Fourier Transforms (FT)- Laplace Transforms (LT)- use of LT for solving complete response of LTI system – transfer function– poles, zeros- impulse response from pole-zero plot – relation between transfer function and frequency response – Block diagrams and structures for system realisation.

Total Hours: 42 Hours

EE2002 LOGIC DESIGN

Pre-requisites: None

L	T	P	C
3	0	0	3

Basic digital circuits - Review of number systems and Boolean algebra - Karnaugh map and Quine McCluskey methods - Boolean function Minimization and combinational design- Ordered Binary Decision diagram (OBDD) and Reduced Order Binary decision diagram (ROBDD) - Combinational circuit design using Multiplexer, ROM, PAL, PLA. - Introduction to Sequential circuits: Latches and flip-flops - Design and analysis of sequential circuits- -State diagrams – Analysis and design of Synchronous sequential Finite Sate Machine – State reduction - Counters: Design of single mode counters and multimode counters - Practical design aspects - Asynchronous sequential logic: Analysis and Design

Total Hours: 42 Hours

EE2003 ELECTRICAL MEASUREMENTS

Pre-requisites: None

L	T	P	C
3	0	0	3

General Principles of measurements -Cathode ray oscilloscope - D'Arsonval Galvanometer - Direct Deflecting Instruments - Measurement of Current, Voltage and resistance – Insulation Resistance, Earth Resistance, Earth Tester Localization of Cable Fault - Measuremet of Power and energy :Dynamometer Type Wattmeter - Ampere Hour Meter - Single and Three Phase Energy Meters (Induction Type) -Current transformer and potential transformer : Trivector Meter - Frequency Meters - Power Factor Meters -DC Potentiometers –A.C. Potentiometers – Various A.C. Bridges - Magnetic Measurements: Ballistic Galvanometer Flux Meter- Magnetic potentiometer- Hall effect devices- Hibbert's Magnetic Standard - Core Loss Measurement- Illumination: Laws of Illumination – standards of luminous intensity- Measurement of luminous intensity- Distribution of Luminous intensity- MSI- Rousseau's construction – Integrating sphere- Illumination Photometers.

Total Hours: 42 Hours

EE2004 BASIC ELECTRONIC CIRCUITS

Pre-requisites: None

L	T	P	C
3	0	0	3

Semiconductors Devices and Small Signal Models - BJT, JFET and MOSFET Amplifier Circuits – Midband Analysis-Transistor as an inverter – switching delays -Charging and discharging a capacitive load by a BJT and MOSFET – rise time and fall time calculations for capacitive load switching -Analysis of basic DTL gate, propagation delay, rise and fall times, fan-in and fan out – power supply current versus frequency of operation - TTL , ECL, CMOS gates - Frequency Response of BJT/FET/MOSFET Amplifiers - Distortion in amplifiers – Low Frequency response of BJT and FET Amplifiers-High Frequency Response of CE current gain- α-cut off and β cut off frequencies - Gain-Bandwidth product-Miller Effect-Emitter Follower at high frequencies-FET and MOSFET amplifiers at high frequencies-Cascode Amplifier

Total Hours: 42 Hours

EE2090 BASIC ELECTRICAL ENGINEERING LABORATORY

Pre-requisites: None

L	T	P	C
0	0	3	2

Study of Analog/Digital meters/Multimeters/CROs, Study of Linear and Non- linear characteristics of loads , Potential divider,Resistance Measurement, Circuit Laws, Power and Power Factor Measurement, Inductance and Mutual Inductance measurement,Earth resistance measurement.

Total Hours: 42 Hours

EE2091 ELECTRONICS LAB - I

Pre-requisites: None

L	T	P	C
0	0	3	2

Use of CRO, Device Characteristics, Rectifiers and Filters, Voltage regulators, Basic BJT and FET Amplifiers

Total Hours: 42 Hours

DETAILED SYLLABI

EE2001 SIGNALS & SYSTEMS

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: First Order LTI Systems in Time-domain (11 hours)

Signals and Systems-

System as interconnection of elements – electrical system elements, thermal system elements, translational and rotational mechanical system elements.

Signal definition – Size of a signal - Classification of signals – Basic signal operations – Commonly used signal models (impulse, step, ramp, complex exponential etc), even and odd components of a signal

Linearity of system elements – element relation – superposition principle – Time-invariance - Bilateral versus unilateral elements

Independent source elements – voltage, current, force, velocity, heat, temperature sources-

Interconnection of elements – interconnection laws for electrical, mechanical and thermal systems

Formulation of System Differential Equation –

Formulation of differential equation for Series and Parallel RC circuits, Series and Parallel RL circuits, mass-damper system, single body heating and cooling system – need for initial condition specification - equivalence between impulse excitation and initial conditions

First-Order Dynamics –

Source-free response of RC circuit – time constant – Source-free response of RL circuit – time constant –Source-free response of first order mechanical system and thermal system – mechanical time constant, thermal time constant – DC switching problem in RC and RL Circuits with and without initial energy storage– Natural response and forced response – transient response – Rise time and fall time in first order systems – Difference between DC switching and applying step input - Complete Solution for step/impulse/sinusoid inputs – First order mechanical system impulse and step response - First order thermal system impulse and step response, generalisations for all first order systems – zero-input response and zero-state response – relation between them to natural response and transient response – superposition principle as applied to various response components –

Concept of steady-state – DC steady-state in RC and RL Circuits – Sinusoidal steady-state in first order systems - sinusoidal steady-state frequency response function of first order systems – periodic steady-state in first order systems.

Module 2: Higher Order LTI Systems in Time-domain – Impulse Response Description (11 hours)

Time-domain analysis of second-order systems –

The mass-spring-damper system (for example, an ammeter or voltmeter) - series and parallel RLC –initial conditions – zero-state and zero-input response components - impulse response – step response – undamped and damped natural frequencies – damping factor – quality factor – undamped spring-mass system and LC system – weakly damped spring-mass system and LC system – Q factor versus rate of decay in stored energy in a weakly damped system - time-domain specifications for a second order system.

Time-domain analysis of higher order systems –

Formulation of differential equation for multi-mesh circuits – determination of initial conditions - solution of n^{th} order Linear ODE using material learnt from Maths-I - natural frequencies – natural frequencies versus stability – frequency response function in terms of coefficients of differential equation - generalisations for n^{th} order linear time-invariant system - Instability in circuits involving dependent sources.

Convolution Integral –

Impulse decomposition of an arbitrary input– convolution integral for zero-state response of a LTI system – importance of impulse response – scanning function – depth of memory of an LTI system and duration of impulse response – relation between DC steady-state output and impulse response – relation between AC steady-state frequency response function and impulse response –

Properties of systems – linearity, time-invariance, causality and stability in terms of impulse response – cascading LTI systems with and without inter-stage interaction –

Zero-state output of an LTI System for complex exponential input – condition of 'dominance' - eigen function – eigen value versus system function – system function $H(s)$ of a n^{th} order LTI system

Module 3: LTI Systems in Frequency-domain - with Periodic Inputs (9 hours)

Signal Expansion in terms of e^{st} kind of signals – Fourier Series

Expansion of an arbitrary input function into a sum of complex exponential inputs of e^{st} type with different values of s - Special case : periodic waveforms – Fourier series – **revise** exponential and trigonometric Fourier

series (covered in Maths-I) – symmetry properties – Fourier series coefficients and time-domain differentiation and integration– rate of decay of harmonic coefficients –

Frequency Response Function of a LTI System

Frequency response function by substituting $s = jw$ in System Function – first order and second order system examples - one-sided frequency response plots versus two-sided frequency response plots – interpreting negative values of ω - symmetry properties of frequency response of LTI systems – use of frequency response and Fourier series to solve for periodic steady-state output in RC, RL and RLC Circuits

Module 4: LTI Systems in Frequency-domain - with Arbitrary Inputs (11 hours)

Signal Expansion in terms of e^{st} kind of signals – Fourier Transforms (FT)

Aperiodic inputs – Fourier Transform from Fourier Series – interpretation of Fourier transform – **revise** what was learnt in Maths-I (properties and theorems)– frequency response function and its role in LTI system solution for aperiodic inputs – band-limiting versus time-limiting of signals – continuity of Fourier transform – convolution theorem – modulation theorem – sampling of CT signals and reconstruction – Nyquist's Theorem on sampling – ideal interpolation versus practical interpolation.

Signal Expansion in terms of e^{st} kind of signals – Laplace Transforms (LT)

Laplace transform from Fourier transform – LT as signal expansion in terms of complex exponential functions – ROC – **revise** what was learnt in Maths-I – Unilateral Laplace Transform – Shifting theorem - use of LT for solving complete response of LTI system – transfer function and its relation with what was called system function earlier – poles, zeros- impulse response from pole-zero plot – relation between transfer function and frequency response –

Block diagrams and structures for system realisation.

Text/Reference Books :

1. Lathi,, B.P., *Signal Processing and Linear Systems*, Oxford University Press, New Delhi, 2006
2. Lathi,, B.P., *Signals, Systems and Communication*, BS Publications, Hyderabad, 2008
3. Shearer, Murphy and Richardson, *Introduction to System Dynamics*, Addison-Wesley Publishing Company, 1967
4. Eronini Umez-Eronini, '*System Dynamics & Control*, Thomson Asia Pvt. Ltd.,Singapore, 1998
5. Charles L. Phillips, John M. Parr & Eve A. Riskin, '*Signals, Systems and Transforms*', Pearson Education, New Delhi, 2008
6. Simon Haykin, Barry Van Veen, '*Signals and Systems*', Wiley India,2nd edn, 2009

EE2002 LOGIC DESIGN

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(12 Hours)**

Basic digital circuits:

Review of number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Boolean function Minimization and combinational design.

Examples of useful digital circuits: Arithmetic Circuits, Comparators and parity generators, multiplexers and demultiplexers, decoders and encoders.

Ordered Binary Decision diagram (OBDD) and Reduced Order Binary decision diagram (ROBDD), unate covering, prime, essential and irredundant properties of implicants, Two level optimization

Module 2: **(11 Hours)**

Combinational logic design:

Combinational circuit design using Multiplexer, ROM, PAL, PLA.

Introduction to Sequential circuits:

Latches and flip-flops (RS, JK, D, T and Master Slave) - Design of a clocked flip-flop – Flip-flop conversion - Practical clocking aspects concerning flip-flops.

Module 3: **(12 Hours)**

Design and analysis of sequential circuits:

General model of sequential networks - State diagrams – Analysis and design of Synchronous sequential Finite Sate Machine – Exact State reduction – State reduction with don't cares - Minimization and design of the next state decoder.

Counters: Design of single mode counters and multimode counters – Ripple Counters – Ring Counters – Shift registers counter design.

Module 4: **(7 Hours)**

Practical design aspects:

Timing and triggering considerations in the design of synchronous circuits – Set up time - Hold time – Clock skew - Static timing analysis - Dynamic analysis.

Asynchronous sequential logic: Analysis and Design – Race conditions and Cycles – Hazards in combinational circuits – Hazard free realization.

Text/Reference Books:

1. M. Mano, "Digital Design", 3rd Ed., Prentice Hall, India.
2. Roth C.H., Fundamentals of Logic Design, Jaico Publishers. IV Ed.
3. W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
4. Tocci, R. J. and Widner, N. S., Digital Systems - Principles and Applications, Prentice Hall, 7th Ed.
5. Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed.
6. D.D. Givone, "Digital Principles and Design", Tata McGraw Hill
7. Katz R, Contemporary Logic Design, Addison Wesley, 1993.
8. Lewin D. & Protheroe D., Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.
9. T. L. Floyd, Digital Fundamentals, Prentice Hall, June 2005.

EE2003 ELECTRICAL MEASUREMENTS

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hours)**

General Principles of measurements, units, dimensions, standards and calibration of meters.
Characteristics of Instruments - qualities and errors of Measurements and its analysis.
Cathode ray oscilloscope - Theory and working –measurements using CRO - Types of CRO – Time base generator circuit – Applications.
principle, construction, operation, torque equation ,calibration and application of D'Arsonval Galvanometer.
Direct Deflecting Instruments - Moving Coil - Moving Iron, Dynamo Meter, Induction, Thermal, Electrostatic and Rectifier Type meters- Shunts and Multipliers- Various Types of Galvanometers. (principle, construction, operation, torque equation and comparison)

Module 2: **(12 Hours)**

Measurement of Current, Voltage and resistance –
Wheatstone bridge - Kelvin Double Bridge - Carey Foster Slide Wire Bridge - Bridge Current Limitations
Insulation Resistance, Earth Resistance, Earth Tester Localization of Cable Fault by Murray and Varley Loop Tests.
Measuremet of Power and energy : Dynamometer Type Wattmeter - Error and Compensation - Ampere Hour Meter - Single and Three Phase Energy Meters (Induction Type) – Calibration- phantom loading.
Current transformer and potential transformer : Construction, theory operation, phasor diagram, characteristics – error elimination and its application.
Trivector Meter - Frequency Meters - Power Factor Meters.

Module 3: **(9 Hours)**

DC Potentiometer –Crompton Potentiometer- Vernier Potentiometer- Diesselhorst Potentiometer-Method of Use-Use of potentiometer for Measurement of Resistance, current and Voltage and power. Applications of DC Potentiometers
A.C. Potentiometers – Applications of AC Potentiometers.
Various A.C. Bridges and Measurement of Inductance & Capacitance and frequency.

Module 4: **(10 Hours)**

Magnetic Measurements: Classification – Magnetometer measurement, Ballistic Galvanometer Flux Meter-Magnetic potentiometer- Hall effect devices- B.H. Curve and Permeability Measurement Hysteresis Measurement– Hibbert's Magnetic Standard - Core Loss Measurement.
Illumination: Laws of Illumination – standards of luminous intensity- Measurement of luminous intensity-Distribution of Luminous intensity- MSI- Rousseau's construction – Integrating sphere- Illumination Photometers.

Reference/Text Books:

1: Golding E.W *Electrical Measurements & Measuring Instruments*, 5e, Reem Publications,2009.
2: Cooper W.D, *Modern Electronics Instrumentation*, Prentice Hall of India, 1996.
3: Stout M.B, *Basic Electrical Measurements*, Prentice Hall, 1986.
4: Oliver & Cage, *Electronic Measurements & Instrumentation*, McGraw Hill, 1979.
5: Sawhney A. K., Electrical and Electronic Measurements and Instrumentation, Dhanpath Rai & Co.,2007

EE2004 BASIC ELECTRONIC CIRCUITS

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: (11 Hours)

Semiconductors Devices and Small Signal Models

Revision of principles of operation of diodes and bipolar junction transistors - transition capacitance of a diode - minority carrier storage-diffusion capacitance-breakdown diodes -schottky diode – forward and reverse recovery processes in a diode -Transistor capacitances – Transistor ratings – Biasing a BJT – Thermal stability of bias.

Concept of small signal operation of semiconductor devices – small equivalent circuit for diodes including capacitances – h-parameter equivalent circuit for a BJT – hybrid-π equivalent for a BJT – determination of small signal parameters from static characteristics- Construction and characteristics of JFETs – capacitances of a JFET – biasing a JFET - small signal model for a JFET-Construction and characteristics of depletion type and enhancement type MOSFETs – MOSFET capacitances – biasing a MOSFET – small signal model of a MOSFET

Module 2: (10 Hours)

BJT, JFET and MOSFET Amplifier Circuits – Midband Analysis.

Amplification in a CE amplifier - CE , CB and Emitter Follower Analysis and Comparison using h parameters as well as hybrid-π parameters - considerations in cascading transistor amplifiers -CS and CD Amplifiers using JFETs and MOSFETs – comparison of BJT, FET and MOSFET amplifiers - Class B and Class AB Power Amplifiers using BJT.

Module 3: (11 Hours)

Digital Electronic Circuits

Transistor as an inverter – switching delays – various components of switch-off and switch-on delays – calculation of switching time components – comparison between high frequency transistor and switching transistor- Charging and discharging a capacitive load by a BJT and MOSFET – rise time and fall time calculations for capacitive load switching- Analysis of basic DTL gate, propagation delay, rise and fall times, fan-in and fan out – power supply current versus frequency of operation -Analysis of basic TTL gate, propagation delay, rise and fall times, fan-in and fan out, ratings, power supply current versus frequency of operation -Different variants of TTL gates-Analysis of basic ECL gate, propagation delay, rise and fall times, fan-in and fan out -Analysis of basic CMOS gate, propagation delay, rise and fall times, fan-in and fan out – power dissipation in the gate and effect of (i) supply voltage (ii) frequency of operation and (iii) load capacitance on gate dissipation -Comparison of various digital logic families.

Module 4: (10 Hours)

Frequency Response of BJT/FET/MOSFET Amplifiers (phasor equivalent circuit approach is envisaged)

Distortion in amplifiers – Non-linear distortion – linear distortion due to frequency response – conditions for distortionless amplification- Low Frequency response of BJT and FET Amplifiers-Dominant Time Constant-Selection of Coupling and Bypass Capacitors -High Frequency Response of CE current gain- α-cut off and β cut off frequencies - Gain-Bandwidth product-Miller Effect-Emitter Follower at high frequencies- FET and MOSFET amplifiers at high frequencies -Cascode Amplifier – BJT discrete version, BJT IC version, MOSFET IC version

Text/Reference Books

1. A.S Sedra and K.C Smith, .'*Microelectronic Circuits*', Oxford University Press, 5th Edn,2009
2. Taub & Scilling, '*Digital Integrated Elecronics*', McGraw-Hill, Singapore, 1997
3. Millman J, '*Microelectronic'*, 2nd edition, McGraw-Hill, New Delhi,2005.
4. Schilling & Belove, '*Electronic Circuits – Discrete and Integrated*', 3rd edition , McGraw-Hill, New Delhi,2006
5. Boylested & Nashesky , Electronic Devices and Circuit Theory, 10th Edn, Pearson Education, New Delhi, 2009

EE2090 BASIC ELECTRICAL ENGINEERING LABORATORY

Pre-requisites: None

L	T	P	C
0	0	3	2

Total Hours: 42 Hours

1. a) Study of Analog/Digital meters/Multimeters/CROs. Interfacing a C.R.O with a PC.
   b) Verification of Kirchhoff's laws in D.C circuits.
2. Study of Linear and Non- linear characteristics of loads – Determination of voltage – current characteristics of linear resistor and linear inductor, incandescent and CFL lambs, iron cored solenoid
3. a) Potential divider connection and study of the dependence of output voltage upon the value of the loading resistance.
   b) Methods of measurement for low- medium-high resistance using voltmeter and ammeter.
4. Verification of Superposition Theorem and Maximum Power Transfer theorem.
5. Verification of Thevenin's Theorem and Generalized Reciprocity theorem.
6. a) study of Fuse, MCB, ELCB – Selection of Fuse rating for circuits.
   b) Determination of fuse characteristics and fusing factor of different specimens (open, enclosed, HRC fuses and MCB).
7. a) Single phase power measurement (fan load) – study of variation of speed, input power and power factor with supply voltage.
   b) Determination of thermal efficiency of an electric kettle.
8. Measurement of power and power factor in R-L-C series and parallel circuits and design of P.F compensator.
9. Three phase power measurement of balanced and unbalanced loads.
10. Experiments and Analysis of Resonance in the RLC circuits and design of an RF circuits to receive an RF signal and verifying it experimentally.
11. Measurement of Self-inductance, Mutual inductance and Coupling coefficient of windings.
12. Measurement of Earth Resistance and Insulation Resistance.

Note: Normally the practical classes are administered in two cycles. Depending on the availability of equipments and time, class coordinators may choose the experiments for each cycle.

Reference/Text Books:

1. H-cotton, Advanced Electrical Technology, Wheeler Publications.
2. Suresh Kumar K.S, Electrcial Circuit and Networks, Pearson Education, New Delhi, 2009
3. EW. Golding Electrical Measurements and Measuring Instruments, 5th edition, reem publications.
4. Huges, Electrical Technology, ed 6

EE2091 ELECTRONICS LAB - I

Pre-requisites: None

L	T	P	C
0	0	3	2

Total Hours: 42 Hours

List of Experiments:

1. Use of CRO: a) Measurement of current, voltage, frequency and phase shift.
2. Semiconductor diodes: V-I and transfer characteristics of Si, Ge and zener diodes.
3. Characteristics of clipping and clamping circuits using diodes and zener diodes.
4. Rectifiers and filters with and without shunt capacitors- Characteristics of half-wave, full wave and bridge rectifiers- Ripple factor, Rectification efficiency, and % regulation.
5. Transistor characteristics in CB and CE configurations - Identification of cut off, active and saturation regions.
6. JFET characteristics in the common source configuration- determination of equivalent circuit parameters.
7. Characteristics of voltage regulators- Design and testing of:
    a) Simple zener voltage regulator
    b) Zener regulator with emitter follower output.
8. UJT Characteristics and UJT relaxation oscillator- Design for a particular frequency.
9. RC coupled amplifier using BJT in CE configuration- measurement of gain, input and output impedance and frequency response
10. BJT emitter follower- Measurement of voltage gain, current gain, input impedance, output impedance and load characteristics
11. FET amplifier- Measurement of voltage gain, current gain, input and output impedance.
12. Power amplifiers- Class AB (complementary symmetry).

Text/Reference Books:

1. Boylested & Nashesky , Electronic Devices and Circuit Theory, 10th Edn, Pearson Education, New Delhi, 2009

SEMESTER IV

Sl. No	Code	Title	L	T	P	C	Category
1	MA2002	Maths – IV	3	1	-	3	BS
2	EE2005	Circuits & Networks	3	-	-	3	PT
3	EE2006	Applied Electromagnetics	3	-	-	3	PT
4	EE2007	Electrical Machines – I	3	-	-	3	PT
5	EE2008	Analog Electronic Circuits & Systems	3	-	-	3	PT
6	ME2007	Mechanical Engineering	3	-	-	3	PT
7	EE2092	Electrical Measurements Lab	-	-	3	2	PT
8	EE2093	Electronics Lab II	-	-	3	2	PT
			18	**1**	**6**	**22**	

BRIEF SYLLABI

EE2005 CIRCUITS & NETWORKS

Pre-requisites: ZZ1001 Basic Electrical Sciences
EE1001 Introduction to Electrical Engineering

L	T	P	C
3	0	0	3

Generalization of time-domain analysis technique for higher order circuits- s-domain Analysis of Circuits - Nodal Admittance Matrix and Mesh Impedance Matrix in the s-domain - circuits with mutual inductance – Generalization of Circuit theorems – Input and transfer immittance functions - Transfer functions - Impulse response and Transfer function - Poles and Zeros - Pole Zero plots – Stability and poles- - frequency response function from s-domain transfer and immittance functions – frequency response of first and second order circuits Graphical evaluation of frequency response function from pole-zero plots, – frequency response specifications for second order functions – correlation between time-domain specs and freq-domain specs in the case of first order and second order circuits. - Bode plot approximation - Frequency response of an ideal and non-ideal two-winding transformer, tank circuits. - three-phase unbalanced sources – symmetrical transformation
Fourier Series -Steady State Solution of Circuits with non-sinusoidal periodic inputs - power and rms value of non-sinusoidal waveforms, Discrete Power Spectrum, THD measure for waveforms. Fourier Transforms - Parseval's theorem - Linear distortion in signal transmission context – Two Port Networks - Two port networks-characterization in terms of impedance, admittance, hybrid and transmission parameters - Symmetrical Two Port Networks - T and Π Equivalent of a two port network – characteristic impedance and propagation constant of a symmetrical two port network - properties of a symmetrical two port network. - Symmetrical Two Port Reactive Networks as Filters - Filter fundamentals-pass and stop bands-behaviour of iterative impedance-Constant-k low pass filter-Constant-k high pass filter- m-derived T and Π sections and their applications for infinite attenuation and filter terminations-constant-k band pass and band elimination filters.

Total Hours: 42 Hours

EE2006 APPLIED ELECTROMAGNETICS

Pre-requisites : Nil

L	T	P	C
3	0	0	3

The Co-ordinate Systems and revision of vector calculus- Electrostatics : Electric Flux and Flux Density; Gauss's law -Energy and Potential . - Capacitors and Capacitances- Method of Images. Steady Electric Currents: -The Equation of Continuity . Joules law- Magnetostatics : The Biot-Savart law. Amperes' Force Law - Magnetic Vector Potential .- Ampere's Circuital law. - Faraday's Law of Induction; Self and Mutual inductance . Maxwell's Equations from Ampere's and Gauss's Laws. Maxwell's Equations in Differential and Integral forms; Equation of Continuity. Concept of Displacement Current. Electromagnetic Boundary Conditions -Poynting's Theorem , Time – Harmonic EM Fields . -Plane wave Propagation : Helmholtz wave Equation-Plane wave solution.-Plane wave propagation in lossless and lossy dielectric medium and conducting medium . Polarization of EM wave - Linear, Circular and Elliptical polarization. Boundary Conditions-Transmission Lines. LCR ladder model for transmission lines. The transmission line equation. - Solution for lossless lines. Wave velocity and wave impedence. Reflection and Transmission coeffcients at junctions. VSWR. Introduction to electromagnetic interference and compatibility

Total Hours : 42 Hours

EE2007 ELECTRICAL MACHINES I

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Electromagnetic Machines - fundamental principles - classification - DC machines - construction - principle of operation - methods of excitation - commutation - armature reaction - generators - power flow diagram - circuit model - performance characteristics - parallel operation - applications - motors - power flow diagram - circuit model - performance characteristics - starting - speed control - testing - permanent magnet DC motor -

applications - transformers - types - construction - principal of operation - parallel operation - testing - different connections of three phase transformers - cooling methods.

Total Hours : 42 Hours

EE2008 ANALOG ELECTRONIC CIRCUITS & SYSTEMS

Pre-requisites: EE2004 Basic Electronic Circuits

L	T	P	C
3	0	0	3

Feedback Amplifiers ,Stability and Oscillators - BJT and MOSFET Differential Amplifiers-Operational amplifier-ideal opamp properties-properties of practical opamps (LM741,LM324,LM358,LF351and OP07)-CMOS Operational Amplifiers – Analysis of opamp circuits using ideal opamp model-Basic linear applications-Series Voltage Regulators-Monolithic Regulators-Three terminal regulators-Regenerative Comparator Circuits - Square, Triangle and Ramp Generator Circuits unction - Principles of VCO circuits-Astable and Monostable Circuits, Sweep circuits, Staircase waveform generation, Timer ICs –Nonlinear Applications-Phase Locked Loops-Active Filtering-Butterworth Low Pass Filter Functions--Sallen and Key Second Order LP Section-Butterworth High Pass Filters-Second Order Wide Band and Narrow Band Bandpass Filters. Multiple Feedback Single OPAMP LPF,HPF & BPF.- Analog Switches-Sample and Hold Amplifier-Data Conversion Fundamentals-D/A Conversion-A/D conversion-

Total Hours : 42 Hours

ME2007 MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

Pre-requisite: nil

Laws of thermodynamics, Engineering Applications of Laws, Carnot cycle, Otto cycle, Diesel cycle, Rankine cycle, Brayton cycle, Principle of internal combustion engines, Refrigeration principles -- vapour compression and absorption refrigeration systems, Psychrometric processes – applications, Fluid flow, Continuity equation, Momentum equation, Energy equation – applications, Flow measurement, Friction in fluid flow, Fluid machines-turbines – pumps -- Cavitation in fluid machinery, Conversion technology of conventional and non-conventional energy sources, Steam power plant, Hydel power plants, Gas turbine power plant, Internal combustion engine power plant.

Number of Hours: 42

EE2092: ELECTRICAL MEASUREMENTS LABORATORY

Pre-requisites: EE2003 Electrical Measurements

L	T	P	C
0	0	3	2

Determination of B-H curve μ_r - H curve and μ_r - B curve of an iron ring specimen -Calibration of magnetic flux meter using standard solenoid, search coil and Hibbert's magnetic standard -Measurement of resistances, capacitance,inducatnce, calibration of meters -Determination of hysteresis loop of an iron ring specimen using 6-point method and CRO -Measurement of branch and node voltage of a given R-L-C circuit using AC potentiometer.- Measurement of candle power of given light sources. Determine the illumination levels at different working planes and verify laws of illumination - Determination of MSCP of an Incandescent lamp/CFL - Determination of the polar curve of candle power distribution and hence find MHCP/MSCP of light sources.

Total Hours : 42 Hours

EE2093 ELECTRONICS LAB II

Pre-requisites : None

L	T	P	C
0	0	3	2

Opamp Linear and non-linear circuits – PLL Applications – Astable and Monostable Circuits – Combinational and Sequential Circuits

Total Hours : 42 Hours

DETAILED SYLLABI

EE2005 CIRCUITS & NETWORKS

Pre-requisites: ZZ1001 Basic Electrical Sciences
EE1001 Introduction to Electrical Engineering

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: – Circuit Analysis in Time-domain and *s*-domain (10 hours)

Time Domain Analysis of Circuits -

Solution of multi-mesh and multi-node circuits (containing RLCM and linear dependent sources) by differential equation method - Determination of initial conditions – Obtaining step response and ramp response of circuits from impulse response – Generalization of time-domain analysis technique for higher order circuits-

[*Review of Laplace Transforms* - Laplace Transform -Transform Pairs-Gate Functions-Shifting Theorem-Solution of Differential Equations by Laplace Transforms - Initial and Final Value Theorems-Laplace Transforms of periodic signals-Inversion of transforms by partial fractions-Convolution Theorem and Convolution Integral. *(Review to be done by students. No class hour will be spent for this review. Home assignments will be given.)*]

s-domain Analysis of Circuits - Transformed equivalent of inductance, capacitance and mutual inductance - Impedance and admittance in the transform domain – concept of the transformed circuit in *s*-domain –

Node Analysis and Mesh Analysis of the transformed circuit - Nodal Admittance Matrix and Mesh Impedance Matrix in the s-domain

Solution of transformed circuits with mutual inductance – step response of an ideal trnsformer – step response of a non-ideal transformer – flux expulsion by short circuited winding –instantaneous change in current in coupled coil systems.

Generalization of Circuit theorems –

Input and transfer immittance functions - Transfer functions - Impulse response and Transfer function - Poles and Zeros - Pole Zero plots – Stability and poles

Module 2: - Sinusoidal Steady-State Frequency Response (12 hours)

Concept of sinusoidal steady-state and frequency response function – frequency response function as a complex function of w as evaluated from phasor equivalent circuit - frequency response function from *s*-domain transfer and immittance functions - explanation for substituting $s = jw$ in *s*-domain transfer function to get frequency response function – frequency response of first order circuits – concept of cut-off frequencies and bandwidth – Series and parallel RC circuits as an averaging filter (for current signal and voltage signal), low-pass filter, high-pass filter, integrator, differentiator, signal coupling circuit, signal bypassing circuit etc. –

Graphical evaluation of frequency response function from pole-zero plots, introduction to filtering and illustration of graphical evaluation of frequency response function from pole-zero plots in the case of standard second order filter functions using Series RLC and Parallel RLC Circuits – frequency response specifications for second order functions – correlation between time-domain specs and freq-domain specs in the case of first order and second order circuits.

Frequency response and bandwidth of cascaded first order circuits with interaction between stages and without interaction between stages.

Bode plot approximation - Transfer function from frequency response data –

Frequency response of an ideal and non-ideal two-winding transformer, tank circuits.

Steady-state analysis of three-phase balanced loads excited by three-phase unbalanced sources – symmetrical transformation – sequence components – sequence impedances – sequence decoupling – power in sequence components.

Module 3: - Fourier Analysis of Circuits (10 hours)

Fourier Series representation of non-sinusoidal periodic waveforms

[*(revision)* - Fourier Coefficients-Determination of Coefficients-Waveform Symmetry-Exponential Fourier Series - Discrete Amplitude and Phase Spectra-*(Review to be done by students. No class hour will be spent for this review. Home assignments will be given.)*]

Steady State Solution of Circuits with non-sinusoidal periodic inputs by Fourier Series and frequency response function, power and rms value of non-sinusoidal waveforms, Discrete Power Spectrum, THD measure for waveforms. – Application of tuned series LC and parallel LC structures in Power Systems – Application of

parallel RLC circuit in Communication circuits – Application of LC circuits in power supply filtering – Application of RLC circuit in power supply decoupling.

Fourier Transforms

[*(revision)* - Aperiodic inputs – Fourier Transform from Fourier Series , properties of Fourier Transforms, Fourier Spectra*(Review to be done by students. No class hour will be spent for this review. Home assignments will be given.)*]

Energy spectral density of finite energy waveforms – Parseval's theorem - energy spectral density of output waveform of a circuit – Relation between impulse response and frequency response of a circuit - Frequency response of Ideal filter functions – why ideal filters can not be realised – time-limited waveforms and continuous nature of their Fourier transforms – band limited Fourier transforms and corresponding time-domain signals - bandwidth measures for Fourier transforms – uncertainty principle in Fourier transforms –

Linear distortion in signal transmission context – amplitude and phase distortion – conditions for distortion-free transmission – why such conditions can not be met in practice – Practical distortion criterion for pulse transmission in terms of energy content of output.

Module 4: Two-port Networks and Passive Filters (10 hours)

Two Port Networks - Two port networks-characterization in terms of impedance, admittance, hybrid and transmission parameters - inter relationships among parameter sets - Reciprocity Theorem-Interconnection of Two port networks: Series, Parallel and Cascade - Input impedance, output impedance and gain of terminated two-ports in terms of two-port parameters and termination impedance – Application of *y, z, g* and *h* parameters in the analysis of negative feedback systems – Application of *ABCD* parameters in the power frequency analysis of transmission lines – T and Π models for a line.

Symmetrical Two Port Networks - T and Π Equivalent of a two port network – T and Π equivalents for Ladder networks, transmission lines, amplifiers etc., iterative impedance and image transfer constant, image impedance – determination of image parameters from open circuit and short circuit impedance measurements - characteristic impedance and propagation constant of a symmetrical two port network - properties of a symmetrical two port network.

Symmetrical Two Port Reactive Networks as Filters - Filter fundamentals-pass and stop bands-behaviour of iterative impedance-Constant-k low pass filter-Constant-k high pass filter- m-derived T and Π sections and their applications for infinite attenuation and filter terminations-constant-k band pass and band elimination filters.

Text/Reference Books :

1. K.S. Suresh Kumar, '*Electric Circuits and Networks*' , Pearson Education, New Delhi, 2009
2. M.E. Van Valkenburg, '*Network Analysis'*, Prentice-Hall India, 3rd Edn, 2010
3. William H. Hayt, Jack E. Kemmerly, *'Engineering Circuit Analysis'*, McGraw-Hill,6th Edn
4. John D. Ryder, '*Networks, Lines and Fields*' , 2nd Edn, Prentice-Hall India, 1989
5. K. V. V. Murthy, M.S. Kamath, '*Basic Circuit Anaysis*',Tata McGraw-Hill, 1989
6. Charles A. Desoer, Ernest S. Kuh, '*Basic Circuit Theory*', McGraw-Hill, New York, 1969

EE2006 APPLIED ELECTROMAGNETICS

Pre-requisites : Nil

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: **(12 Hrs)**

The Co-ordinate Systems; Rectangular, Cylindrical, and Spherical Co-ordinate System. Co-ordinate transformation. Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field. Their Physical interpretation. The Laplacian. Divergence Theorem, Stokes' Theorem. Useful Vector identifies

Electrostatics : The experimental law of Coulomb, Electric field intensity. Field due to a line charge, Sheet Charge and Continuous Volume Charge distribution. Electric Flux and Flux Density; Gauss's law.

Application of Gauss's law. Energy and Potential . The Potential Gradient. The Electric dipole. The Equipotential surfaces. Energy stored in an electrostatic field. Boundary Conditions. Capacitors and Capacitances. Poisson's and Laplace's equations. Solutions of Simple Boundary value problems. Method of Images.

Module 2: **(10 Hrs)**

Steady Electric Currents: Current densities , Resistance of a Conductor; The Equation of Continuity . Joules law. Boundary Conditions for Current densities. The EMF. Magnetostatics : The Biot-Savart law. Amperes' Force Law . Torque exerted on a current carrying loop by a magnetic field. Gauss's law for magnetic fields. Magnetic Vector Potential . Magnetic Field Intensity and Ampere's Circuital law. Boundary conditions. Magnetic Materials . Energy in magnetic field . Magnetic circuits. Application to cathode Ray Oscilloscope.

Module 3: **(10 Hrs)**

Faraday's Law of Induction; Self and Mutual inductance . Maxwell's Equations from Ampere's and Gauss's Laws. Maxwell's Equations in Differential and Integral forms; Equation of Continuity. Concept of Displacement Current, Electromagnetic Boundary Conditions.

Poynting's Theorem , Time – Harmonic EM Fields . Application to Transformer. Plane wave Propagation : Helmholtz wave Equation. Plane wave solution. Plane wave propagation in lossless and lossy dielectric medium and conducting medium . Plane wave in good conductor, surface resistance , depth of penetration. Polarization of EM wave - Linear, Circular and Elliptical polarization. Normal and Oblique incidence of linearly Polarized wave at the plane boundary of a perfect conductor, Dielectric – Dielectric Interface . Reflection and Transmission Co-efficient for parallel and perpendicular polarizations , Brewstr angle.

Module 4: **(10Hrs)**

The TEM wave and the transmission line limit - Transmission Lines: The high-frequency circuit. Time domain reflectometry. LCR ladder model for transmission lines. The transmission line equation. Analogy with wave equation. Solution for lossless lines. Wave velocity and wave impedence. Reflection and Transmission coeffcients at junctions. VSWR. Introduction to electromagnetic interference and compatibility

Text/Reference Books:

1. Nannapaneni Narayana Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India.
2. Elements of Electromagnetic by Mathew N. O. Sadiku, Publisher Oxford University Press.
3. Fields and Wave Electromagnetics, By David K. Cheng, 2nd Edition , Publisher : Pearson Education.
4. Electromagnetics By John D Kraus , (Mcgraw-Hill)

EE2007 ELECTRICAL MACHINES I

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: Electromagnetic Machines **(8 hours)**

Fundamental principles - classification - generators, motors and transformers - elements of electromagnetic machines - armature windings - commutator winding - lap winding and wave winding - phase winding - single phase winding and three phase winding - single layer winding and double layer winding - MMF of a winding - space harmonics - torque developed in a winding - EMF developed in a winding - distribution factor - chording factor.

Module 2: DC Machines **(7 hours)**

Construction - principle of operation - magnetic circuit - flux distribution curve in the air-gap - EMF equation - armature reaction - demagnetizing and cross magnetizing ampere turns - commutation - methods of excitation - generators and motors.

Module 3: DC Generators and Motors **(12 hours)**

DC Generators: Power flow diagram -circuit model - magnetization characteristics - process of voltage build up - terminal characteristics - control of terminal voltage - parallel operation - applications.

DC Motors: Power flow diagram - circuit model - back EMF - torque and speed equations performance characteristics - applications - starting methods - design of starters - methods of speed control - testing - Swinburne's test - Hopkinton's test - separation of losses - retardation test - permanent magnet DC motor.

Module 4: Transformers **(15 hours)**

Types and construction - principle of operation - magnetizing current - harmonics - ideal and real transformer - dot convention - current and voltage ratio - equivalent circuit - phasor diagram - per unit impedance - losses - efficiency and regulation - all day efficiency - OC and SC tests - Sumpner's test - parallel operation - tap changing - switching transients - auto transformers - voltage and current relationships - saving of copper - different connections of three phase transformers - notations - Scott connection - cooling methods.

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Langsdorf A.S., Principles of DC Machines, McGraw Hill.6th edition, 1959.
3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
4. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
5. Toro V.D, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
6. Chapman S.J, Electric Machinery Fundamentals, McGraw Hill, 2nd edition, 1991.
7. Nagarath I.J. & Kothari D.P, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.

EE2008 ANALOG ELECTRONIC CIRCUITS & SYSTEMS

Pre-requisites: EE2004 Basic Electronic Circuits

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: **(11 Hours)**

Feedback Amplifiers ,Stability and Oscillators (s-domain approach is envisaged)

Concept of Feedback-Negative and Positive Feedback-Loop Gain-Closed Loop Gain-Voltage Series Feedback on a single time constant voltage to voltage amplifier-Advantages of negative feedback in a single time constant voltage to voltage amplifier-gain, input and output resistances, rise time, bandwidth, nonlinearity etc- stability and positive feedback in the above amplifier-Voltage Shunt,Current series and Current Shunt topologies and properties.
Voltage Series feedback on a second order amplifier-Closed Loop poles and loop gain-Transient Response of Closed Loop Amplifier vs Loop Gain-Voltage Series Amplifier with third order open loop amplifier-pole migration to right half of s-plane – Bode Plots of Loop Gain-Barkhausen's criterion for stability of feedback amplifiers-Gain Margin and Phase Margin-Introduction to amplifier compensation-dominant pole compensation-Oscillators- Transistor Phase Shift Oscillator-Wein's Bridge Oscillator

Module 2: **(11 Hours)**

Linear Opamp Circuits

BJT and MOSFET Differential Amplifiers-Common Mode and Differential Mode gains-CMRR-Current Source Biasing-Offset behaviour.
Current Sources for biasing inside an IC.
Operational Amplifier-ideal opamp properties-properties of practical opamps (LM741,LM324,LM358,LF351and OP07)-different stages in an opamp-internally compensated and externally compensated opamps-slew rate -offsets.
CMOS Operational Amplifiers – basic two-stage CMOS Opamp – Folded Cascode Opamp
Analysis of opamp circuits using ideal opamp model-concept of virtual short and its relation to negative feedback-offset model of a practical opamp-
Non inverting Amplifier-Gain bandwidth product-Voltage Follower-Inverting Amplifier-Summing Amplifier-Offset analysis of Non inverting and inverting amplifiers-Subtracting Circuit-Instrumentation Amplifier-Voltage to Current Converter for floating and grounded loads-Opamp Integrator-Opamp Differentiator.
Series Voltage Regulators-Monolithic Regulators-Three terminal regulators.

Module 3: **(10 Hours)**

Nonlinear IC Applications

Regenerative Comparator Circuits using Opamps-Comparator IC LM311 and its applications-Square, Triangle and Ramp Generator Circuits using Opamps and Comparator ICs-Effect of Slew Rate on waveform generation-Study of Function Generator IC ICL8038- Principles of VCO circuits-
Opamp based Astable and Monostable Circuits, Sweep circuits, Staircase waveform generation, Timer ICs – 555 Applications
Precision half wave and full wave rectification using opamps-
Log and antilog amps and applications.
Phase Locked Loops-Principles-Lock and Capture Ranges-Capture Process-Loop Filter-PLL dynamics under locked condition-study of NE564 and CD 4046-Applications of PLL in signal reconstruction, noise rejection, frequency multiplication, frequency synthesis, FSK demodulation, FM demodulation, line synchronization etc.

Module 4: **(10 Hours)**

Signal Conditioning and Signal Conversion

Active Filtering-Butterworth Low Pass Filter Functions-Low Pass Filter Specifications-order and cut off frequency of Butterworth Function from Low Pass Specifications-Sallen and Key Second Order LP Section-Gain Adjustment in Butterworth LP filters-Butterworth High Pass Filters-Second Order Wide Band and Narrow Band Bandpass Filters. Multiple Feedback Single OPAMP LPF,HPF & BPF.
Analog Switches-Sample and Hold Amplifier-Data Conversion Fundamentals-D/A Conversion-Weighted Resistor DAC- R/2R Ladder DAC-Current Switching DAC-Multiplying DAC-Bipolar DACs-A/D conversion-Quantiser Characteristics-Single Slope and Dual Slope ADCs-Counter Ramp ADC-Tracking ADC - Successive Approximation ADC-Simultaneous ADC.

Text/Reference Books:

1. A.S Sedra and K.C Smith, .*'Microelectronic Circuits*', Oxford University Press, 5th Edn,2009
2. Millman J, '*Microelectronic'*, 2nd edition, McGraw-Hill, New Delhi,2005.
3. Schilling & Belove, '*Electronic Circuits – Discrete and Integrated*', 3rd edition , McGraw-Hill, New Delhi,2006
4. D.H. Sheingold, .Nonlinear Circuits Handbook., Analog Devices Inc. 1976
5. Sergio Franco, '*Design with Operational Amplifiers and Analog Integrated Circuits*', Tata McGraw-Hill, New Delhi, 2005
6. M.E Van Valkenburg, '*Analog Filter Design'*, Oxford University Press 2001
7. National Semiconductor, '*Linear Applications Handbook'*, 1994
8. Anvekar D.K. & Sonde B.S, '*Electronic Data Converters'*, Tata McGraw Hill,1994
9. Gayakwad R.A, '*OPAMPS & Linear Integrated Circuits'*, 3rd edition, Prentice Hall of India,1995.
10. Clayton G.B,'*Operational Amplifiers'*, 5th edition, Oxford ,2004
11. Frederiksen T.M, '*Intuitive Operational Amplifiers'*, McGraw Hill,1996.

ME2007 MECHANICAL ENGINEERING

Pre-requisite: nil

L	T	P	C
3	0	0	3

Number of Hours: 42

Module 1 **(10 hours)**

Thermodynamics: Thermodynamic systems, Properties, Processes, Heat and work, Zeroth law of thermodynamics, First law of thermodynamics -- concept of internal energy and enthalpy -- steady flow energy equation -- applications, Second law of thermodynamics -- concept of entropy -- absolute zero -- heat engine -- refrigerator -- heat pump.

Module 2 **(10 hours)**

Engineering applications of thermodynamics: Carnot cycle, Otto cycle, Diesel cycle – applications, Principle of operation of two stroke and four stroke engines, Spark ignition and compression ignition engines – applications, Rankine cycle, Brayton cycle -- their applications.

Refrigeration -- methods of producing cold, Refrigeration cycle -- vapour compression system – vapour absorption system – applications, Psychrometric properties, Psychrometric processes.

Module 3 **(12 hours)**

Fluid mechanics and fluid machinery: Fluid properties – viscosity -- surface tension -- fluid pressure -- measurement of viscosity and pressure, Centre of pressure, Buoyancy, Classifications of flow, Continuity equation, Bernoulli's equation, Momentum equation – applications, Friction in flow passages, Flow measuring instruments.

Fluid machinery: Air compressors -- working principles – loads -- characteristics and electric power requirement.

Hydraulic turbines – classifications -- performance characteristics – governing -- cavitation,

Hydraulic pumps – classification -- performance characteristics – cavitation -- electric power requirements.

Module 4 **(10 hours)**

Power plant Engineering: Conversion technology of conventional and non-conventional energy sources.

Steam power plant: Layout -- steam generators -- types of boilers for power station.

Hydel power plants: Layout -- classifications and study of various components -- operation

Gas turbine power plant and Internal Combustion engine power plants. Layout -- schemes -- study of various components – operation.

Text/Reference books:

1. Cengel, Y.A., and Boles, M.A, *Thermodynamics- An Engineering approach*, 6th edition, McGraw Hill, 2008.
2. Cengel, Y.A., and Cimbala, J.M., *Fluid mechanics*, 2nd ed., McGraw Hill, 2010.
3. Zemansky, M.W., Basic *Engineering Thermodynamics*, 2nd ed., McGraw hill, 2002.
4. Spalding, D.B., and Cole, B.H., *Thermodynamics*, 3rd ed., Arnold, 1987.
5. Gill, P.W., and Smith J.H., *Internal combustion engines*, 4th ed., United States Naval Institute, 2010.
6. Joseph Heitner, *Automotive systems*, 2nd ed., D. Van Nostrand company Inc, 1984
7. Streeter, V.L., *Fluid Mechanics*, 8th ed., McGraw Hill 1985.
8. Krivchenko, G.I., *Hydraulic Machinery*, 2nd ed., Lewis Publishers, 1994.
9. Skrotsky, B., Vopat, H., *Power Plant Engineering*, 2nd ed., McGraw hill, 1985.
10. Gredrick, T. Morse, *Power Plant Engineering*, 3rd ed., Van Nostrand Company,1994
11. El-Wakil, M.M., *Power Plant Engineering*, 1st ed., McGraw Hill, New York, 1985.
12. Stoecker, W.F. and Jones, *Refrigeration & Air conditioning*,2nd edition, McGraw Hill, New York,1987
13. Nag, P.K., *Engineering thermodynamics*, 4th ed., McGraw Hill, 2008.
14. Jagdish Lal , *Hydraulics and fluid mechanics*, 9th ed., Metropolitan, 1987.

EE2092: ELECTRICAL MEASUREMENTS LABORATORY

Pre-requisites: EE2003 Electrical Measurements

L	T	P	C
0	0	3	2

Total Hours : 42 Hours

LIST OF EXPERIMENTS:

1. Determination of B-H curve μ_r - H curve and μ_r - B curve of an iron ring specimen.
2. Calibration of magnetic flux meter using standard solenoid, search coil and Hibbert's magnetic standard.
3. a) Measurement of low/medium resistance using Kelvin's double bridge and wheat stone's bridge.
   b) Measurement of various cable resistance as per ISI specifications.
4. a) Measurement of Capacitance and Inductance using AC bridges.
   b) Measurement of Inductive and capacitive reactance at HF, VHF and UHF ranges.
5. Calibration of dynamometer type wattmeter using slide wire potentiometer.
6. Extension of range of ammeter/voltmeter using shunt/series resistance and calibration of the extended meter using standard ammeter/voltmeter.
7. Extension of range of a dynamometer type wattmeter using CT/PT and calibration of the extended meter using a standard wattmeter.
8. Calibration of single – phase energy meter by direct loading and phantom loading at various power factors.
9. Calibration of 3-phase energy meter using standard wattmeter.
10. Determination of hysteresis loop of an iron ring specimen using 6- point method and CRO.
11. Measurement of branch and node voltage of a given R-L-C circuit using AC potentiometer.
12. a)Measurement of candle power of given light sources. Determine the illumination levels at different working planes and verify laws of illumination.

. b) Determination of MSCP of an Incandescent lamp/CFL.

c) Determination of the polar curve of candle power distribution and hence find MHCP/MSCP of light sources.

Text/Reference Books

1. Golding E.W, Electrical Measurements & Measuring Instruments, 5e reem publications, 2009.
2. Cotton.H,. Advanced Electrical Technology,
3. Suresh Kumar K.S Electric Circuit and Networks, Pearson education.
4. Cooper W.D, Modern Electronics Instrumentation , Prentice Hall of India, 1986

EE2093 ELECTRONICS LAB II

Pre-requisites : None

L	T	P	C
0	0	3	2

Total Hours : 42 Hours

List of experiments

1. OPAMP circuits - design and set up of inverter - scale changer - adder - non-inverting amplifier - integrator and differentiator
2. OPAMP comparator - design and set up of Schmitt trigger - window comparator
3. Phase shift and Wein's bridge oscillator with amplitude stabilization using OPAMPs
4. Waveform generation - square, triangular and saw tooth wave form generation using OPAMPs
5. Precision rectification - absolute value and averaging circuit using OPAMPs
6. Second order LP and BP filters using single OPAMP
7. Using CD 4046 (PLL), study the dynamics of set up (a) Frequency multiplier (b) FSK MOD/DEMOD using PLL
8. Set up analog to digital converter (a) successive approximation method (b) dual slope method
9. Using UP DOWN COUNTER and a DAC Ics, generate triangular waveform

a) Using Cd 40447 IC, design and set up gated/ungated astable and monostable multivibrators

b) Using Cd 4093 Schmitt NAND IC, design and set up astable and monostable multivibraors

10. Design of Half adder and half subtractor circuits with NAND gates using mode control

a) Design and realization of ripple counter using JK flip-flop

b) Cascading of ripple counters

11. Design and realization of Johnson & Ring counter using (a) JK flip flop (b) shift register
12. Synchronous UP/DOWN counter design and realization
13. IC 555 applications

Text/Reference Books:

1. A.S Sedra and K.C Smith, .*'Microelectronic Circuits*', Oxford University Press, 5th Edn,2009

SEMESTER V

Sl. No.	Code	Title	L	T	P	C	Category
1	EE3001	Microprocessors & Microcontrollers	3	-	-	3	PT
2	EE3002	Control Systems -1	3	-	-	3	PT
3	EE3003	Electrical Machines - II	3	-	-	3	PT
4	EE3004	Power Systems - I	3	-	-	3	PT
5		Elective - 1	3	-	-	3	PT
6		Elective - 2	3	-	-	3	PT
7	ME3094	Mechanical Engineering Lab	-	-	3	2	PT
8	EE3091	Electrical Machines Lab - I	-	-	3	2	PT
			18	**-**	**6**	**22**	

LIST OF ELECTIVES - VTH SEMESTER

S.No	Code	Title	Credit
1	EE3021	Electrical Engineering Materials	3
2	EE3022	Network Analysis & Synthesis	3
3	EE3023	Optimization Techniques and Algorithms	3
4	EE3024	Special Machines and Linear Machines	3
5	EE3025	Electric Power Utilization	3
6	EE3026	Dynamic Analysis of Electrical Machines	3
7	EE3027	Linear System Theory	3
8	EE3028	High Voltage Engineering	3
9	EE3029	Non-conventional Energy Systems and Application	3
10	EE3030	Applications of Analog Integrated Circuits	3

BRIEF SYLLABI

EE 3001 MICROPROCESSORS AND MICROCONTROLLERS

Pre-Requisites : None

L	T	P	C
3	0	0	3

Introduction – Number systems, Memory, system organization – PIC as a tool to learn micro controllers – Peripherals in the microcontroller - Programming and simulation - Intel 8086 microprocessor – Its architecture and programming – Interfacing chips – Timer – Peripheral interface – DMA controller – Serial communication controller.

Total Hours : 42 Hours

EE3002 CONTROL SYSTEMS - 1

Pre-requisites : None

L	T	P	C
3	0	0	3

General scheme of control systems – – ON-OFF, P, PI ,Pd and PID control – Modelling of dynamic systems- Transfer function – State space modeling- concept of state – state equations general formulation – matrix-vector formulation for linear systems- state model for typical systems- state space model from differential equations and transfer function – canonical models - non-uniqueness of state models -transfer function from state model.Time domain analysis of SISO control systems- Solution of linear time invariant state equation .Stability of linear systems –Frequency domain methods – Frequency domain specifications – correlation with time domain parameters.Discrete time systems-Sampling Process- Z Transform and Inverse Z Transform- Pulse transfer functions - State model for discrete time systems- time response from z transform and state models.

Total Hours: 42 Hours

EE3003 ELECTRICAL MACHINES II

Prerequisite: None

L	T	P	C
3	0	0	3

Alternators - construction - principle of operation - armature reaction - phasor diagrams - predetermination of voltage regulation - two reaction theory - methods of excitation - synchronous machines - power angle characteristics - reactance power - load sharing upon parallel operation - automatic synchronizing - effect of change in fuel supply and excitation - synchronizing power and torque - automatic voltage regulators - synchronous motor - principle of operation - equivalent circuit - phasor diagram - mechanical load diagram - V curves - inverted V curves - O curves - torque and power relations - hunting - different starting methods - three phase induction motors - construction - principle of operation - phasor diagram - equivalent circuit - torque slip characteristics - no-load and blocked rotor tests - circle diagram - double cage rotors - cogging and crawling - induction generators - single phase induction motors - double revolving field theory - equivalent circuit - starting methods and speed control of three phase induction motors - starting methods of single phase induction motors.

Total Hours: 42 Hours

EE3004 POWER SYSTEMS – I

Pre-requisites : None

L	T	P	C
3	0	0	3

Conventional sources of electrical energy- Overhead transmission systems-Transmission line parameters- Distribution systems- Energy Conservation Measures- Power quality issues and mitigation techniques- distribution system planning and automation-Switch gear and protection.

Total Hours: 42 Hours

EE3021 ELECTRICAL ENGINEERING MATERIALS

Pre-requisites: None

L	T	P	C
3	0	0	3

Conducting materials: quantum free electron theory- Fermi-Dirac distribution - Materials for electric resistances- general electric properties: brushes of electrical machines, lamp filaments ,fuses and solder. -Semiconductors: Mechanism of conduction in semiconductors. Magnetic materials: magnetic materials used in electrical machines instruments and relays -Dielectrics - Insulating materials - Special purpose materials and processes - Super conductors –Materials for electronic components –

Total Hours: 42 Hours

EE3022 NETWORK ANALYSIS & SYNTHESIS

Pre-requisite: EE2005 Circuits & Networks

L	T	P	C
3	0	0	3

Network Topology: Loop analysis of networks (with independent and dependant sources) –Mesh analysis- Duality –Node pair analysis – Analysis using generalized branch model (node, loop and node pair analysis) – Tellegen's theorem for lumped parameter network in topological form -

Network functions for one port and two port networks – Hurwitz polynomials – properties - Brune's positive real functions – Properties of positive real functions - Necessary and sufficient conditions for positive real functions – Sturm's test for positive real functions-Synthesis of reactive one-ports by Foster's and Cauer's methods - Synthesis of LC, RC and RL driving-point functions – RLC one terminal-pair network synthesis – Minimum positive real functions – Brune's method of RLC synthesis – Series Parallel realization – Chop- chop method - The method of Bott and Duffin –Two terminal–pair synthesis –The LC ladder development –The RC ladder development – Gullimen's transfer admittance synthesis

Total Hours : 42 Hours

EE3023 OPTIMIZATION TECHNIQUES AND ALGORITHMS

Pre-Requisites : None

L	T	P	C
3	0	0	3

Concepts of optimization- Classical Optimization Techniques- Linear programming- Engineering Applications- Nonlinear programming- Unconstrained optimization- Basic decent methods- Nonlinear programming-Dynamic programming- Optimization programming, tools and Software: MATLAB- SIMULINK, FSQP, SOLVER, LINDO etc.

Total Hours: 42 Hours

EE3024 SPECIAL MACHINES AND LINEAR MACHINES

Prerequisite: EE2007 Electrical Machines I

L	T	P	C
3	0	0	3

Servo motors -Requirement of a good servomotor, Types of servomotors, construction, operating principle and application. Symmetrical components applied to two - phase servo motors - servo motor torque. Stepper motors - construction features - method of operation half stepping and the required switching sequence - the reluctance type stepper motor. Reluctance motors - construction, principle and classification Hysteresis motors- construction, principle and classification, torque develop and slip. Universal motors - characteristics - circuit model and phasor diagram. Linear machines - basic difference between LEMS and rotating - machine – classification of LEMSDC linear motors Edge Effect, MMF wave and its velocity, air gap flux density.

Total Hours: 42 Hours

EE3025 ELECTRIC POWER UTILIZATION

Prerequisite: EE3004 Power Systems I

L	T	P	C
3	0	0	3

Electric Traction: Features of an ideal traction system-systems of electric traction- mechanism of train movement Speed control Schemes-Electric braking, Electric heating: classification- heating element-losses in oven and efficiency- resistance furnace- radiant heating- induction heating- high frequency eddy current heating- -Electric welding:- methods and equipments- Electrolysis and Electroplating applications. Illumination: radiant energy-terms and definitions- laws of illumination- polar curves- photometry- MSCP- integrating sphere- luminous efficacy- colorimeter, design of interior and exterior lighting systems- illumination levels for various purposes-light fittings- factory lighting- flood lighting-street lighting-energy conservation in lighting. Air conditioning and refrigeration: Control of temperature - protection of motors. Technology of electric and hybrid electric vehicles.

Total Hours: 42 Hours

EE3026 DYNAMIC ANALYSIS OF ELECTRICAL MACHINES

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

Electro dynamical equation and their solution- Condition for conversion of average power- Voltage and torque equation of a primitive 4 winding commutator machine- Three phase to two phase and commutator transformation of three phase induction and synchronous machine, voltage and torque equation, steady state, transient and small signal analysis- Dynamical analysis of interconnected machines.

Total Hours: 42 Hours

EEU 3027 LINEAR SYSTEM THEORY

Pre-requisites: None

L	T	P	C
3	0	0	3

Introduction to the concepts of dynamic systems modelling and analysis design and development-System Dynamics-Modelling of electrical systems- passive networks- d c and a c motors linear models –transfer functions for simple electrical and electromechanical systems. n- convolution –block diagrams and signal flow graphs- Mason's gain formula. Modelling of non-electrical systems-Development of linearised models-Superposition principle- Fourier representation of aperiodic signals- Fourier transform and inverse Fourier transform pairs- Stability of linear systems Routh Hurwitz criterion – limitations.Time domain and Frequency domain analysis. Computer simulation of systems.

Total Hours: 42 Hours

EE 3028 HIGH VOLTAGE ENGINEERING

Pre-requisites : None

L	T	P	C
3	0	0	3

Generation of High AC, DC and impulse voltages, Generation of switching surge voltage and impulse currents, Measurement of high voltages and currents-DC, AC and impulse voltages and currents, High voltage testing of materials and apparatus-preventive and diagnostic tests- Natural causes of over voltages - principles of insulation co-ordination, Different types of insulating materials and reasons for breakdown, Insulating materials used in various equipments.

Total Hours: 42 Hours

EE3029 NON-CONVENTIONAL ENERGY SYSTEMS AND APPLICATIONS

Pre-requisites : None

L	T	P	C
3	0	0	3

Renewable energy systems- Principles- Solar energy- solar collectors-solar water heaters- Applications Solar thermal power generation- Solar Photovoltaics- equivalent circuit -MPPT algorithms- Wind energy- wind turbines- characteristics- Dynamics matching- applications- Storage Devices- Super capacitor-SMES- Battery storage-flywheel storage- compressed air storage- Fuel cells–types and applications; MHD generators- Bioenergy- Ocean Energy- mini, micro and pico hydel power

Total Hours: 42 Hours

EE 3030 APPLICATIONS OF ANALOG INTEGRATED CIRCUITS

Pre-requisite: EE 2004 Basic Electronic Circuits & EE 2008 Analog Electronic Circuits

L	T	P	C
3	0	0	3

Internal analysis of a typical BJT Opamp and a typical CMOS Opamp –Linear and Non-linear application of Opamp – Operational Transconductance Amplifiers and applications – Active Opamp-RC filters -Log/Antilog Amplifiers and Applications, Analog Multipliers . Log / Antilog , Transconductance Type and TDM Type .Applications of Multipliers - True RMS to DC Converters - Phase-Locked Loops, Monolithic PLLs, PLL Applications- Direct Digital Synthesis of Waveforms. Hardware Design Techniques. Grounding and Shielding, Power Supply Filtering and Noise reduction, Grounding in Mixed Signal Systems, EMI/RFI considerations.

Total Hours: 42 Hours

EE3091 ELECTRICAL MACHINES LAB I

Pre-requisite: EE2007 Electrical Machines I

L	T	P	C
0	0	3	2

12 Experiments on characteristics of DC Generators, DC Motors and Transformers

Total Hours: 42 Hours

ME3094 MECHANICAL ENGINEERING LABORATORY

Pre-requisite: ME2007 Mechanical Engineering

L	T	P	C
0	0	3	2

Experiments on Flow measurement, Characteristics of turbines, Pumps, IC Engines and Air Compressors

Number of Hours: 42

DETAILED SYLLABI

EE 3001 MICROPROCESSORS AND MICROCONTROLLERS

Pre-Requisites : None

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: **(8 hours)**

Basics of computer – Number systems – Computer languages of different levels – compilers – cross compilers - History of Microprocessors – Computer architecture (Block diagram) – Memory types, Addressing concept.

Module 2: **(13hours)**

Microcontrollers

Microchip PIC 18F 452 Microcontroller - Introduction - Architecture – Memory organization - Assembly Language programming – simulation using MPLAB IDE - Programming of I/O ports – Addressing modes - Bank switching – Table processing – Timers and its programming – Interrupt programming.

Module 3: **(10hours)**

Intel 8086 processor- Architecture — addressing modes – Instruction set – assembly Language programming – Interrupts Pin configuration of 8086 – Timing diagrams – Minimum and maximum mode –address decoding .

Module 4: **(11 hours)**

Interfacing chips – Programmable peripheral interface (8255) - Programmable timer (8253)- -serial communication interface (8251) –DMA controller (8257) - Programmable Interrupt Controller (8259).

Text/Reference Books

1. Muhammad Ali Mazidi, - Rolin D.Mckinlay, Danny Causey. PIC microcontroller and Embedded Systems. 2008 1st Edition , Pearson Education.
2. Lyla B Das - The x86 Microprocessors – 1st Edition – Pearson Education, 2010
3. T R Padmanabhan - Introduction to Microcontrollers and their applications – 1st Edition 2007 – Narosa Publishing House Pvt Ltd..
4. Hall D V , Microprocessors & Interfacing , Second Edition ,1991 McGraw Hill.
5. Brey B B , The Intel Microprocessors, Architecture , Implementation & Programming, 2005,7th edition, McGraw Hill
6. Peter Norton - Peter Norton's Intro to Computers, 6th Edition, 2006, McGraw Hill.
7. Dr Badri Ram - Fundamentals of Microprocessors and Microcomputers . 3rd Edition, 1989, Dhanpat Rai & Sons.

EE3002 CONTROL SYSTEMS - 1

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1: **(11 hrs)**

General scheme of control systems – open loop and closed loop – SISO and MIMO systems- effect of feedback in SISO systems- regulator and tracking systems- feedback control strategies – ON-OFF, P, PI ,Pd and PID control – Modelling of dynamic systems- Transfer function – DC Motor-AC Motor- Thermal and pneumatic systems- Control actuators – power amplifiers – amplidyne-magnetic amplifier- pneumatic and hydraulic actuators- sensors and control valves- tachometer- shaft encoders- synchro and flow sensors..

Transfer function and impulse response (review)- derivation for typical closed loop systems- block diagrams reduction and signal flow graphs – Mason's gain formula.

State space modeling- concept of state – state equations general formulation – matrix-vector formulation for linear systems- state model for typical systems- state space model from differential equations and transfer function – canonical models - non-uniqueness of state models -transfer function from state model

Module 2: **(11 hrs)**

Time domain analysis of SISO control systems- standard test inputs- impulse, step, ramp and sinusoidal inputs- under damped and over damped responses – first order systems – time constant – second order systems- damping factor natural frequency –and other transient response specifications- higher order systems – steady state error and error constants – error for polynomial type inputs –

Solution of linear time invariant state equation – zero input (free) and zero state(forced) responses – state transition matrix- definition and properties- complete response – output response – bounded input bounded output – eigen values and nature of responses.

Module 3: **(10 hrs)**

Stability of linear systems – BIBO stability – characteristic equation roots and stability – Routh Hurwitz criterion for stability – stability from eigen values of system matrix.

Frequency domain methods – root locus techniques – frequency response plots – Polar plots and Bode plots – stability from open loop gain functions – Nyquist criterion – relative stability – gain margin, phase margin etc from polar plot and Bode plot – stability from Bode plot. Frequency domain specifications – band width- cut of frequency etc - Closed loop frequency domain specifications-peak resonance and resonant frequency- correlation with time domain parameters.

Module 4: **(10 hrs)**

Introduction to Sampled data and discrete time systems-Sampling Process- uniform rate sampling - ideal sampler- Definition of Z Transform and Inverse Z Transform-Z-Transform & Inverse Z Transform pairs-Theorems of Z transform-Sample & Hold- Zero order Hold-Finite pulse width sampling-Examples for finding z-Transform and Inverse z-Transforms. Pulse transfer functions - State model for discrete time systems- time response from z transform and state models.

Text/Reference Books:

1. Modern Control Engineering, Katsuhiko Ogata, Pearson Prentice Hall , 2006
2. Control Systems, M Gopal, Tata McGraw Hill, 3rd Edition, 2006
3. Modern Control Engineering, K P Mohandas, Revised Edition, Sanguine Pearson, 2010.
4. Digital Control Systems, Benjamin C Kuo, Oxford University Press, 1992.

EE3003 ELECTRICAL MACHINES II

Prerequisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Alternators **(12 hours)**

Construction - principle of operation - type and selection - armature reaction - voltage regulation - predetermination of voltage regulation - EMF method - synchronous reactance and short circuit ratio - MMF method - Potier method - phasor diagrams - two reaction theory - modified phasor diagram - analysis by two reaction theory - sudden short circuit - current waveforms - transient and sub transient reactance - slip test - DC excitation - static excitation - brush less excitation and self excitation - measurement of losses.

Module 2: Synchronous Machines **(12 hours)**

Power angle characteristics of cylindrical rotor and salient pole machines - reactance power - active and reactive power control - load sharing upon parallel operation - effect of armature reactance - automatic synchronizing - effect of change in fuel supply and excitation - alternator connected to infinite bus - governor characteristics - synchronizing power and torque - phasor diagram for two identical generators in parallel - locus of generated voltage for constant real power and variable excitation - automatic voltage regulators - synchronous motor - principle of operation - equivalent circuit - effect of load changes on synchronous motor - mechanical load diagram - armature current as function of power developed and excitation - V curves - inverted V curves - O curves - transition of a machine from generator mode to motor mode - phasor diagram - torque and power relations - minimum excitation for given power - hunting - periodicity of hunting - suppression - different starting methods.

Module 3: Induction Machines **(12 hours)**

Three phase induction motors - construction - principle of operation - rotor MMF and production of torque - slip and frequency of rotor current - phasor diagram - equivalent circuit - mechanical power developed - maximum torque - torque slip characteristics - losses and power flow - single phasing - no-load and blocked rotor tests - circle diagram - effect of deep bar and double cage rotors - effects of air gap flux harmonics - cogging and crawling - line excited and self excited induction generators - single phase induction motors - double revolving field theory - equivalent circuit - applications of all types of induction motors.

Module 4: Starting & Speed Control of Induction Motors **(6 hours)**

Starting methods of three phase induction motors - direct on line starting - auto transformer starting - star delta starting - rotor resistance starting - starters and contactors - basic methods for speed control of three phase induction motors - voltage control - frequency control - rotor resistance control - pole changing - static frequency conversion and slip power recovery scheme - starting methods of single phase induction motors.

Text/Reference Books:

1. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
2. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.
3. Fitzgerald A.E. & Kingsley: Electrical Machinery, Tata McGraw Hill.,6th edition, 2003.
4. Chapman S.J, Electric Machinery Fundamentals, McGraw Hill., 2nd edition, 1991.
5. Toro V.D, Electrical Machines & Power Systems, Prentice Hall, 2nd edition, 2003.
6. Puchestein, Lloyd & Cenrad,Alternating Current Machines, Asia Publishing House.,1962.
7. Nagarath I.J. & Kothari D.P, Electric Machines, Tata McGraw Hill, 3rd edition, 2004.
8. P.S. Bimbra, Generalized Theory of Electrical Machines, Khanna Publishers,2001

EE3004 POWER SYSTEMS – I

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 hours)**

Conventional sources of electrical energy - thermal, hydroelectric, diesel and nuclear power plants - renewable energy sources - power plant economics - operating costs - load factor - demand factor - diversity factor - plant factor - tariffs-distributed generation-microgrid-smartgrid.

Module 2: **(10 hours)**

Overhead transmission systems - arrangement of conductors - sag and tension - transmission line supports - choice of transmission voltage - line insulators - failure of insulation - corona - underground cables - different types - capacitance of single core and three core cables - grading of cables.

Module 3: **(10 hours)**

Distribution systems - classification and arrangement of distribution systems - distribution substation layout and arrangement - economic loading of distribution transformers - Kelvin's law - considerations in primary and secondary distribution system design - current distribution and voltage drop calculation-design of feeders and distributors - improvement of existing distribution systems - LT capacitor installation – System and equipment earthing-Energy Conservation Measures- Power quality issues and mitigation techniques-distribution system planning and automation-traction-heating-welding-lighting.

Module 4: **(12 hours)**

Switch gear and protection .Circuit breaker-Types-rating .Selection -Neutral earthing .Lightning and protection - Protective Relays-Functions-Types of Relays-protection schemes- NEC and importance of relevant IS/IEC Specifications

Text/Reference Books:

1. Soni, Gupta, Bhatnagar, "A course in Electric Power", Dhanpat Rai & Sons, NewDelhi, 9 ed.,1996.
2. A.T. Starr, "Generation, Transmission & Utilization of Electric Power", Sir Issac Pitman and Sons, 4 ed., 1973
3. Turan, Goren, "Electric Power Transmission System Engineering", John Wiley, 1988
4. S.L. Uppal, "Electric Power", Khanna Publishers, 1992.
5. A.S. Pabla, "Electric Power Distribution System", Tata McGraw Hill, 1992.
6. M N Bandyopadhyay, "Electrical Power Systems- Theory and Practice", Prentice Hall of India, 2006.
7. Weedy B M, Cory B J, "Electric Power Systems", John Wiley Publication, 4 ed., 1998.
8. Sunil S Rao, "Switch Gear Protections", Khanna Publications, Delhi 1999
9. T S Madhav Rao, "Power system protection static relays with microprocessor Applications", Tata McGraw hill Publication,1998.
10. Badri Ram, D N Vishwakarma, " Power System Protection and Switchgear', Tata Mc Graw Hill, 2005.

EE3021 ELECTRICAL ENGINEERING MATERIALS

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(12 hours)**

Conducting materials: Review of metallic conduction on the basis of free electron theory-electrical and thermal conductivity-Wiedemann-Franz law-drawback of classical theory-quantum free electron theory- Fermi-Dirac distribution - variation of conductivity with temperature and composition, Materials for electric resistances-general electric properties: brushes of electrical machines, lamp filaments ,fuses and solder.

Semiconductors: Mechanism of conduction in semiconductors. density of carriers in intrinsic semiconductors - the energy gap - types of semiconductors. Hall Effect - compound semiconductors - basic ideas of amorphous and organic semiconductors

Magnetic materials: Classification of magnetic materials - origin of permanent magnetic dipoles - ferromagnetism - hysterisis curve-magnetostriction - hard and soft magnetic materials- magnetic materials used in electrical machines instruments and relays.

Module 2: **(12 hours)**

Dielectrics: Dielectric polarization under static fields - electronic, ionic and dipolar polarizations - behavior of dielectrics in alternating fields - mechanism of breakdown in gases, liquids and solids- factors influencing dielectric strength- capacitor materials-Ferro and piezo electricity

Insulating materials-complex dielectric constant - dipolar relaxation . dielectric loss insulator materials used - inorganic materials (mica, glass, porcelain, asbestos) - organic materials (paper, rubber, cotton silk fiber, wood, plastics, bakelite) - resins and varnishes - liquid insulators(transformer oil) - gaseous insulators (air, SF6, and hydrogen) – ageing of insulators.

Module 3: **(10 hours)**

Special purpose materials and processes: Thermo couple materials-soldering materials- fuse materials-contact materials-structural materials-fluorescent and phosphorescent materials- galvanizing and impregnation process –

Super conductors – effect of magnetic field- Meissner effect-type I and type II superconductors –London equations –Josephson effect –applications of superconductors

Module 4: **(8 hours)**

Materials for electronic components – resistors –insulated moulded resistors-Cracked carbon resistors-alloy resistors-metallic oxide thin film resistors-High value resistors-wire wound resistors-non linear resistors – varistors –capacitors-mica- dielectric capacitors-glass-dielectric capacitors-plastic-dielectric capacitors etc – inductors –air cored coils –cored coils-ferrite core-relays-

Text/Reference Books:

1. Indulkar C.S.& Thiruvengadam S, An Introduction to ElectricalEngineering Materials, S. Chand Co,1998.
2. P.K. Palanisamy ,Solid State Physics, SCITECH Publications,Hyderabad, 2004
3. A.J. Dekker,"Electrical Engineering Materials" Prentice Hall of India
4. Yu Koritsky, Electrical Engineering Materials., MIR,1970
5. Arumugam M., Materials Science., Anuradha Publishers, 1990
6. Kapoor P.L., Electrical Engineering Materials., Khanna Publications,
7. Hutchison T.S. & Baird D.C, The Physics of Engineering Solids., John Wiley Publications

8. S.O.Kasap,Principles of Electrical engineering Materials and Devices, Tata Mc Graw Hill.
9. R.K. Rajput," Electrical Engg. Materials," Laxmi Publications
10. T. K. Basak, "Electrical Engineering Materials" New age International.
11. Solymar, "Electrical Properties of Materials" Oxford University Press.
12. Ian P. Hones," Material Science for Electrical and Electronic Engineering," Oxford University Press.
13. Meinal A.B.& Meinal M.P, Applied Solar Energy -An Introduction., Addison Wesley Publications,1977.
14. TTTI Madras, Electrical Engineering materials, Tata Mc Graw Hill, 1999.

EE3022 NETWORK ANALYSIS & SYNTHESIS

Pre-requisite: EE2005 Circuits & Networks

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: – Network Analysis using Linear Graph Theory (12 Hrs)

Network Topology:

Linear Oriented Graphs - incidence matrix – Kirchoff's Laws in incidence matrix form – nodal analysis (with independent and dependant sources) – Circuit matrix of linear oriented graph – Kirchoff's laws in fundamental circuit matrix form - Loop analysis of networks (with independent and dependant sources) – Planar graphs – Mesh analysis- Duality – Cut set matrix - Fundamental cut set matrix – Relation between circuit, cut set and incidence matrices – Kirchoff's laws in fundamental cut set form – Node pair analysis – Analysis using generalized branch model (node, loop and node pair analysis) – Tellegen's theorem for lumped parameter network in topological form.

Module 2: - Network Functions and Elements of Realizability (10 Hrs)

Review of Network Functions:

Network functions for one port and two port networks – Poles and Zeros of network functions – Restrictions on pole and zero locations for driving–point functions – Restrictions on pole and zero locations for transfer functions – Concept of stability

Elements of Realizability:

Hurwitz polynomials – properties - Brune's positive real functions – Properties of positive real functions - Necessary and sufficient conditions for positive real functions – Sturm's test for positive real functions

Module 3: - Synthesis of reactive one - port networks (12 Hrs)

Elementary synthesis operations:

Removal of pole at infinity – Removal of pole at zero – Removal of conjugate imaginary poles- Synthesis procedure

Driving point synthesis:

Frequency response of reactive one ports – Synthesis of reactive one-ports by Foster's and Cauer's methods - Synthesis of LC driving-point functions – Properties of driving point immitances – Pole Zero interpretation - First and Second Foster forms of LC networks – First and Second Cauer forms of LC networks - Synthesis of RC and RL driving–point functions – Properties of RC network functions – First and Second Foster forms of RC networks – First and Second Cauer forms of RC networks – Properties of RL network functions – First and Second Foster forms of RL networks –First and Second Cauer forms of RL networks - RLC one terminal-pair network synthesis – Minimum positive real functions – Brune's method of RLC synthesis – Series Parallel realization – Chop- chop method - The method of Bott and Duffin – Actual realization difficulties

Module 4: - Synthesis of reactive two - port networks (8 Hrs)

Two terminal–pair synthesis – Some properties of y_{12} and z_{12} – The coefficient conditions – Transfer immittances with positive coefficients – Constant resistance symmetric lattice - Zeros of transmission – The LC ladder development – Common ground impedance and admittance synthesis - Zero shifting by partial pole removal – Zero producing by complete pole removal – The RC ladder development – Gullimen's transfer admittance synthesis

Text/Reference Books

1. Van Valkenburg M.E: *Introduction to Modern Network Synthesis*, John Wiley & Sons, 1962.
2. K. S. Suresh Kumar, *Electric Circuits and Networks*, 1st Ed, Pearson Education, 2009
3. Umesh Sinha, *Network Analysis& Synthesis*, 5th Ed, Satyaprakashan, 2001.
4. Van Valkenburg M.E: *Network Analysis*, Prentice Hall India, 1989
5. Dov Hazony, *Elements of Network Synthesis*, East West Publishers, 1971.
6. Franklin F Kuo, *Network Analysis and Synthesis*, John Wiley, 2001

EE3023 OPTIMIZATION TECHNIQUES AND ALGORITHMS

Pre-Requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem.

Classical Optimization Techniques: Single and multi variable problems-Types of Constraints Semi definite case-saddle point.

Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity - formulation of LP problems - simplex method and algorithm -Matrix form- two phase method.

Duality- dual simplex method- LU Decomposition. Sensitivity analysis. Artificial variables and complementary solutions-QP.

Engineering Applications: Minimum cost flow problem, Network problems-transportation, assignment & allocation, scheduling . Karmarkar method-unbalanced and routing problems.

Module 2: **(11 Hrs)**

Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming - gradient and Hessian.

Unconstrained optimization: First & Second order necessary conditions-Minimization & Maximization-Local & Global convergence-Speed of convergence.

Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-Lagrange multiplier method - Kuhn-tucker conditions . Quasi-Newton method- separable convex programming - Frank and Wolfe method, Engineering Applications.

Module 3: **(10 Hrs)**

Nonlinear programming- Constrained optimization: Characteristics of constraints-Direct methods-SLP,SQP-Indirect methods-Transformation techniques-penalty function-Lagrange multiplier methods-checking convergence- Engineering applications

Module 4: **(10 Hrs)**

Dynamic programming: Multistage decision process- Concept of sub optimization and principle of optimality-Computational procedure- Engineering applications.

Genetic algorithms- Simulated Annealing Methods

Optimization programming, tools and Software: MATLAB- SIMULINK, FSQP, SOLVER, LINDO etc.

Text/Reference Books:

1 David G Luenberger, “Linear and Non Linear Programming”, 2nd Ed, Addison-Wesley Pub.Co., Massachusetts, 1973

2 W.L.Winston, “Operation Research-Applications & Algorithms”, Thomson publications, 2003.

3 S.S.Rao, “Engineering Optimization”, 3rd Ed., New Age International (P) Ltd, New Delhi,2004

4 W.F.Stoecker, “Design of Thermal Systems”, 3rd Ed., McGraw Hill, 1989.

5 G.B.Dantzig, “Linear Programming and Extensions”, Princeton University Press, 1963.

6 L.C.W.Dixton, “Non Linear Optimization: theory and algorithms”, Birkhauser, Boston, 1980

7 Bazarra M.S, Sherali H.D. & Shetty C.M., “Nonlinear Programming Theory and Algorithms”, John Wiley, New York,1979.

8 Kalyanmoy Deb, “Optimization for Engineering Design-Algorithms and Examples”, Prentice Hall India-1998

EE3024 SPECIAL MACHINES AND LINEAR MACHINES

Prerequisite: EE2007 Electrical Machines I

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Servo Motors **(12 Hrs)**

Servo motors -Requirement of a good servomotor, Types of servomotors: D. C. servomotor: Basic working principle and its classification, Field controlled and Armature controlled DC servomotor, Application: servo-stabilizer and position control system. AC servo motor: construction, operating principle and Application. Symmetrical components applied to two - phase servo motors -equivalent circuit and performance based on symmetrical components - servo motor torque - speed curves.

Module 2: Stepper Motors **(8 Hrs)**

Stepper motors - construction features - method of operation - drive - amplifiers and transistor logic -Drive Circuits - half stepping and the required switching sequence - the reluctance type stepper motor – ratings. Characteristics of Stepper Motor- Stepper motor application.

Module 3: **(11 Hrs)**

Reluctance motors - General types of synchronous motors - Reluctance motors - definitions - construction - polyphase and split phase reluctance motors - capacitor type reluctance motors

Hysteresis motors - Construction - polyphase - capacitor type and shaded pole hysteresis motors –Methods of reversing direction of rotation in shaded pole motor. Advantage over reluctance motors, Torque develop and slip

Universal motors – Applications - torque characteristics - essential parts of universal motors - EMF due to main filed and cross field - Transformer and rotational emf - circuit model and Phasor Diagram.

Module 4: Linear Machines **(11 Hrs)**

Linear machines - basic difference between LEMS and rotating - machine – classification of LEMS, linear motors and levitation machines - linear induction motors - linear synchronous motors - DC linear motors - linear levitation machines, Edge Effect, MMF wave and its velocity, air gap flux density

Text/Reference Books

1. Toro.V.D, “Electric machines and power systems”, Prentice Hall of India, 1985.
2. Veinott, “Fractional horse power electric motors”, Mc Graw Hill, 1948
3. Nasar.S.A,Boldeal, “Linear Motion Electric machine”, John Wiley,1976
4. V.U.Bakshi U.A.Bakshi, “Electrical Circuits And Machines”, Technical Publication, Pune,2008.
5. V V Athani, “Stepper Motors: Fundamentals Applications and Design” , New Age International 2007.
6. Fitzgerald, Charles Kingsley, Stephen D. Umans, “Electric machinery”, Tata McGraw-Hill 2002.

EE3025 ELECTRIC POWER UTILIZATION

Prerequisite: EE3004 Power Systems I

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Electric Traction (11 Hrs)

Electric Traction: Features of an ideal traction system-systems of electric traction- mechanism of train movement- speed-time curve, Power and Power Measurement, traction supply system- transmission line to substation- feeding and distributing system on an ac traction- system of current collection-traction motors-tractive effort and horse power- Speed control Schemes-Electric braking.

Module 2: Electric Heating (11 Hrs)

Electric heating: classification- heating element-losses in oven and efficiency- resistance furnace- radiant heating- induction heating- high frequency eddy current heating- dielectric heating- arc furnace- heating of buildings-Electric welding:- methods and equipments- Electrolysis and Electroplating applications, Heating of Bare Conductors.

Module 3: Illumination (10 Hrs)

Illumination: radiant energy-terms and definitions- laws of illumination- polar curves- photometry- MSCP-integrating sphere- luminous efficacy- electrical lamps- Color values of illuminates and color effects: colorimeter, artificial daylight, design of interior and exterior lighting systems- illumination levels for various purposes- light fittings- factory lighting- flood lighting-street lighting-energy conservation in lighting.

Module4: Air-Conditioning and Refrigeration (10 Hrs)

Air conditioning and refrigeration: Control of temperature - protection of motors - simple heat load and motor calculations. Air-conditioning - function of complete air conditioning system - type of compressor motor. Cool storage - estimation of tonnage capacity and motor power. Technology of electric and hybrid electric vehicles.

Text/Reference Books:

1. Taylor E Openshaw, “Utilisation of Electric Energy”, Orient Longman,1986.
2. J B Gupta, “Utilization of electric power and electric traction”, S K Kataria & Sons, 2002.
3. Wadhwa. C.L., “Generation, Distribution and utilization of electrical energy”, Wiley Eastern Limited,1993.
4. Soni, Gupta, Bhatnagar, “A course in electric power”, Dhanapat Rai & sons, 2001.
5. S.L.Uppal, “Electrical Power”, Khanna pulishers,1988.
6. Partab H., “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Sons, New Delhi. Second edition
7. Tripathy S.C., “Electric Energy Utilization And Conservation”, Tata McGraw Hill,1993 .
8. Web sites: bee-india.org, eia.doe.gov, www.irfca.org.
9. IEEE bronze book-IEEE press
10. William Edward Barrows, “Light, Photometry and Illumination”, BiblioBazaar, LLC, 2009

EE3026 DYNAMIC ANALYSIS OF ELECTRICAL MACHINES

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(12 Hrs)**

Electro dynamical Equations and their Solution . A Spring and Plunger System- Rotational Motion System . Mutually Coupled Coils . Solution of Electrodynamical Equations by Euler's method and Runge-Kutta method . Linearisation of the Dynamic Equations and Small Signal Stability . Differential Equations of a smooth air-gap two winding machine . Conditions for Conversion of Average Power in such a Machine . A two phase machine with current excitation - Interpretation of the Average Power Conversion Conditions in terms of air-gap Magnetic Fields. The Primitive 4 Winding Commutaor Machine- The Brush Axis and its Significance . Self and Mutually induced voltages in the stationary and commutator windings . Speed e.m.f induced in Commutator Winding . Rotational Inductance Coefficients . Sign of Speed e.m.f terms in the Voltage Equation . The Complete Voltage Equation of Primitive 4 Winding Commutator Machine . The Torque Equation . Analysis of Simple DC Machines using the Primitive Machine Equations.

Module 2: **(11 Hrs)**

The Three Phase Induction Motor . Equivalent Two Phase Machine by m.m.f equivalence . equivalent two phase machine currents from three phase machine currents . Power Invariant Phase Transformation . Voltage Transformation . Voltage and Torque Equations of the Equivalent Two Phase Machine . Commutator Transformation and its interpretation . Transformed Equations . Different Reference Frames for Induction Motor Analysis . Nonlinearities in Machine Equations . Equations under Steady State - Solution of Large Signal Transients in an Induction Machine . Linearised Equations of Induction Machine . Small Signal Stability . Eigen Values . Transfer Function Formulation.

Module 3: **(10 Hrs)**

The Three Phase Salient Pole Synchronous Machine . Three Phase to Two Phase Transformation . Voltage and Torque Equations in stator, rotor and air-gap field reference frames . Commutator Transformation and Transformed Equations . Parks Transformation . Suitability of Reference Frame Vs kind of Analysis to be Carried out . Steady State Analysis . Large Signal Transient Analysis . Linearisation and Eigen Value Analysis . General Equations for Small Oscillations . Small Oscillation Equations in State Variable form . Damping and Synchronizing Torques in Small Oscillation Stability Analysis . Application of Small Oscillation Models in Power System Dynamics.

Module 4: **(9 Hrs)**

Dynamical Analysis of Interconnected Machines . Machine Interconnection Matrices . Transformation of Voltage and Torque Equations using Interconnection Matrix . Large Signal Transient Analysis using Transformed Equations . Small Signal Model using Transformed Equations . The DC Generator/DC Motor System . The Alternator /Synchronous Motor System . The Ward-Leonard System . Hunting Analysis of Interconnected Machines Selection of proper reference frames for individual machines in an Interconnected System.

Text/Reference Books:

1. Sengupta D P & J.B. Lynn, "Electrical Machine Dynamics", The Macmillan Press Ltd.
2. Jones C V, "The Unified Theory of Electrical Machines", Butterworth, London.
3. Woodson & Melcher, "Electromechanical Dynamics", John Wiley & Sons.
4. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company

EEU 3027 LINEAR SYSTEM THEORY

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: (11 Hrs)

Introduction to the concepts of dynamic systems modelling and analysis design and development-Definition of system –System Dynamics--Feedback-Classification of systems- static, dynamic, linear, non-linear, time varying, time invariant, distributed, lumped, continuous time, discrete time, discrete event, systems etc.- Modelling of electrical systems- passive networks- d c and a c motors linear models –Concept of transfer function – transfer functions for simple electrical and electromechanical systems. Impulse response and transfer function- convolution –block diagrams and signal flow graphs- Mason's gain formula

Module 2: (10 Hrs)

Modelling of non-electrical systems- Examples of simple pneumatic, hydraulic and thermal and liquid level systems-control valves - Translational and rotational systems- D'Alembert's principle-Modelling of electromechanical systems, force-voltage and force-current analogy- Comparison of RLC Circuits and Mass-Spring-Damper system- Development of linearised models- Superposition principle-Linearized model for Inverted Pendulum. Introduction to Time delay systems.

Module 3: (11 Hrs)

Fourier representation of aperiodic signals- Fourier transform and inverse Fourier transform pairs-Properties of Fourier transforms. Continuous amplitude and phase spectra-Relation between Laplace transforms and Fourier transforms. Concepts of attenuation, amplification and filtering of signals.

Stability of linear systems – open loop and closed loop stability – bounded input bounded output stability -Routh Hurwitz criterion – limitations

Module 4: (10 Hrs)

Time domain and Frequency domain analysis of single input-single output linear time invariant systems-Determination of Impulse response-Analysis of response to other standard inputs- step, ramp ,acceleration and sinusoidal inputs- Time domain performance measures for first order and second order systems- under-damped and over-damped systems- Significance of damping factor. Definition of order and type of dynamical systems-steady state and dynamic error-Determination of error constants from transfer functions- Analysis of response of higher order systems- Effect of poles and zeros. Frequency response – Bode plots – performance criteria in frequency domain – band width – cut off frequency – gain margin –phase margin. Computer simulation of systems.

Text/Reference Books:

1. David K Cheng: A*nalysis of Linear Systems*, Narosa Publishers,1998.
2. Gene F Franklin, J David Powell, Abbas Emami Naeini, *Feedback Control of Dynamic Systems*, 4th Ed, Pearson Education Asia, 2002
3. M. Gopal *Control Systems Engineering*, Tata McGrah Hill , 2008.
4. John J D'Azzo, Constantine H Houpis, Stuart N. Sheldon, *Linear Control System Analysis & Design with MATLAB*, 5th Ed, Marcel Dekker, 2003
5. Burton T.D., *Introduction to Dynamic Systems*, McGrawHill, 1994
6. John Dorsey, *Continuous & Discrete Control Systems*, McGrawHill, 2002.
7. Wayne H Chen, *The Analysis of Linear Systems*, McGrawHill, 1963.
8. Benjamin Kuo, *Automatic Control Systems*, 7th Ed, Prentice Hall India,1995.
9. Norman S. Nise, *Control Systems Engineering*, 4th Ed., John Wiley, 2004
10. Chi-Tong Chen, *Linear System Theory and Design*, Oxford University Press, 1999

EE 3028 HIGH VOLTAGE ENGINEERING

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Generation of High voltages and currents: AC voltages: cascade transformers-series resonance circuits. DC voltages: voltage doubler-cascade circuits-electrostatic machines Impulse voltages: single stage and multistage circuits-wave shaping-tripping and control of impulse generators Generation of switching surge voltage and impulse currents

Module 2: **(11 Hrs)**

Measurement of high voltages and currents-DC,AC and impulse voltages and currents-DSO-electrostatic and peak voltmeters-sphere gaps-factors affecting measurements-potential dividers(capacitive and resistive)-series impedance ammeters-rogowski coils-hall effect generators

Module 3: **(10 Hrs)**

High voltage testing of materials and apparatus-preventive and diagnostic tests-dielectric loss measurements-schering bridge-inductively coupled ratio arm bridge-partial discharge and radio interference measurement-testing of circuit breakers and surge diverters

Module 4: **(11 Hrs)**

Introduction to Insulation materials: Different types of insulating materials, Insulating materials used in various equipments. Breakdown in gas and gas mixtures-breakdown in uniform and non uniform fields-Paschens law-Townsends criterion-streamer mechanism-corona discharge-breakdown in electro negative gases- Breakdown in liquid dielectrics-Breakdown in solid dielectrics.

Natural causes of over voltages- lightning phenomena - over voltages due to switching surges - system faults and other abnormal conditions for different voltage levels- principles of insulation co-ordination

Text/Reference Books:

1. Kuffel and Zaengal , “High Voltage Engineering Fundamentals”, Newness, 2 ed.2002
2. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 3 ed.,1995.
3. M. Khalifa, "High Voltage Engineering: Theory and Practice", Dekker, 1990.
4. H. M. Ryan, "High Voltage Engineering and Testing", IEE 2001.
5. Kuffel and Abdullah.M, “High Voltage Engineering”, Pergamon press,1978
6. Wadhwa C L, “High Voltage Engineering”, New Age International, NewDelhi,1994
7. Relevant IS standards and IEC standards
8. Haddad A , Warne D F, “Advances in High Voltage Engineering”, IEE publication,2004
9. Standard techniques for high voltage testing, IEEE Publication 1978.

EE3029 NON-CONVENTIONAL ENERGY SYSTEMS AND APPLICATIONS

Pre-requisites : None

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

Module 1: **(12 Hrs)**

Introduction to renewable energy various aspects of energy conversion-Principle of renewable energy systems-environment and social implications

Solar energy: Solar radiation components- measurements-estimation-solar collectors-solar water heaters-Calculation-Types-analysis-economics-Applications Solar thermal power generation

Solar Photovoltaics- energy conversion principle-classifications-equivalent circuit-characteristics-Cell efficiency- Limitations-PV modules-MPPT algorithms

Module 2: **(9 Hrs)**

Wind energy: Basics of wind-wind turbines-power and energy from wind turbine-characteristics- - types of electric generators for wind power generation. Dynamics matching- performance of wind generators - applications- economics of wind power

Module 3: **(10 Hrs)**

Storage Devices: Super capacitor-SMES- Battery storage-flywheel storage- compressed air storage- Fuel cells–types and applications; MHD generators – backup -System design-industrial and domestic applications.

Module 4: **(11 Hrs)**

Bioenergy: Bio fuels-classification-biomass conversion technologies-applications; Ocean Energy: Tidal energy-wave energy-ocean thermal energy conversion systems-applications; - mini, micro and pico hydel power

Text/Reference Books:

1. Godfrey Boyle, “Renewable Energy: Power for a sustainable future”, Oxford University press, Second edition.
2. Rai G D, “Solar Energy Utilization”, Khanna Publishers, 1997.
3. B H Khan, “Non-Conventional Energy Resources”, The McGraw-Hill Companies, Second Edition.
4. Sukhatme, S.P, “Solar Energy -Principles of Thermal Collection and Storage”, Tata
5. McGraw-Hill, 2 ed., 1997.
6. Sammes, Nige, “Fuel Cell Technologies-State and Perspectives”, Springer publication, 2005
7. Kreith, F., and Kreider, J.F., “Principles of Solar Engineering”, Mc-Graw-Hill Book Co, 1978.
8. S.L.Soo , “Direct Energy Conversion” , Prentice Hall Publication, 1968
9. James Larminie, Andrew Dicks, **“**Fuel Cell Systems”, Wiley & Sons Ltd, 2ed, 2003.
10. E.J. Womack , “MHD power generation engineering aspects” , Chapman, Hall Publication, 1969.

EE 3030 APPLICATIONS OF ANALOG INTEGRATED CIRCUITS

Pre-requisite: EE 2004 Basic Electronic Circuits & EE 2008 Analog Electronic Circuits

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Various Stages of an Operational Amplifier, Active Load, Current Mirror –

Simplified Schematic Circuit of a typical BJT Opamp, Bias and Small Signal Analysis of a typical BJT Opamp, Bias and Small Signal Analysis of a typical two-stage CMOS Opamp, Bias and Small Signal Analysis of a typical folded cascode CMOS Opamp

Ideal and practical characteristics of Opamps, Compensating an Opamp, Offset model of opamp and offset analysis of simple application circuits, special design opamps, auto-zero amplifiers, single supply opamps and applications. Noise Dynamics and Properties. Sources of Noise and Low-Noise Op Amps

Module 2: **(10 Hrs)**

Applications : Amplifiers for Signal Conditioning, Schmitt Triggers, analog switches, comparator ICs, precision rectifiers, precision clipping circuits,Sine, Triangular, Sawtooth, and Monolithic Wave Generators, Multivibrators , V-F and F-V Converters, VCO Circuits, Timers.Voltage References and Regulators. Switching, linear, and monolithic switching regulators. Switching Regulator Control ICs , Battery Charging Control ICs.Operational Transconductance Amplifiers . Applications

Module 3: **(12 Hrs)**

Active Filters: Categories of Filters, LP,HP,BP,BE and All Pass Filters, Second Order s-domain equations in each case and their pole-zero plots. The Filter approximation problem - Butterworth Approximation, Chebyshev and Inverse Chebyshev Approximations, frequency transformations. Biquad Topologies, Analysis and Design of Single OPAMP Biquads with finite gain . Analysis and design of LP,HP and BP Filter with second order response KHN (Universal Active Filter) Filter, Tom-Thomas Biquad, Analysis and Design for various categories of filters.- OTA .C Tunable Filters.

SC Filters, SC Resistor, First and second Order SC Filters, Structure for LP, HP, BP and BE SC Filters

Module 4: **(10 Hrs)**

Applications and Design Techniques: Log/Antilog Amplifiers and Applications, Analog Multipliers . Log / Antilog , Transconductance Type and TDM Type .Applications of Multipliers - True RMS to DC Converters -

Phase-Locked Loops, Monolithic PLLs, PLL Applications- Direct Digital Synthesis of Waveforms. Hardware Design Techniques. Grounding and Shielding, Power Supply Filtering and Noise reduction, Grounding in Mixed Signal Systems, EMI/RFI considerations.

Text/Reference Books:

1. A.S Sedra and K.C Smith, .Microelectronic Circuits., Holt Saunders International Edition-3,1989
2. D.H. Sheingold, .Nonlinear Circuits Handbook., Analog Devices Inc. 1976
3. Clayton , .Operational Amplifiers., Butterworth Publications,1979
4. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits., Mc Graw Hill, 1988
5. M.E Van Valkenburg, Analog Filter Design., Oxford University Press 2001
6. National Semiconductor, Linear Applications Handbook., 1994
7. Analog Devices Inc, Practical Design Techniques for Thermal and Power Management., 2004
8. Analog Devices Inc , RMS to DC Conversion Application Guide.
9. Analog Devices Inc., A Designers. Guide to Instrumentation Amplifiers.
10. Analog Devices Inc., Practical Design Techniques for Sensor Signal Conditioning.

EE3091 ELECTRICAL MACHINES LAB I

Pre-requisite: EE2007 Electrical Machines I

L	T	P	C
0	0	3	2

Total Hours: 42 Hours

List of Experiments

1. Determination of open circuit characteristic of a dc shunt generator and its analysis.
2. Load test on a dc shunt generator, determination of internal/ external characteristics and analysis.
3. Break test on dc shunt and series motors, determination of performance characteristics and analysis.
4. Swinburne's test on a dc shunts motor and predetermination of efficiency of the machine.
5. Hopkinton's test on a pair of dc shunts machines and predetermination of their efficiencies.
6. Retardation test on a dc shunt machine and separation of losses.
7. No load test on a dc shunt machine and separation of losses.
8. OC and SC tests on a single-phase transformer and predetermination of efficiency/ regulation.
9. Separation of losses in a single-phase transformer.
10. Sumpner's test on a pair of single-phase transformers and predetermination of efficiency/ regulation.
11. Scott connection of two single-phase transformers and performance evaluation.
12. Polarity test on single phase transformers and three phase connections of the same.

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Langsdorf A.S., Principles of DC Machines, McGraw Hill.6th edition, 1959.
3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
4. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.

ME3094 MECHANICAL ENGINEERING LABORATORY

Pre-requisite: ME2007 Mechanical Engineering

L	T	P	C
0	0	3	2

Number of Hours: 42

Fluid mechanics lab:
Flow measurement -- venturi meter -- nozzle meter -- orifice meter – notches, Friction factor for various types of flows through pipes, Metacentric height for floating bodies.

Hydraulic machinery lab:
Characteristics of turbines – Pelton turbine -- Francis turbine, Characteristics of pumps – centrifugal pump -- reciprocating pump -- gear pump.

Heat engines lab:
Properties of oils – viscosity -- flash and fire points, Constant speed characteristics of internal combustion engines – spark ignition engines and compression ignition engines, Characteristics air compressors

SEMESTER VI

Si.No	Code	Title	L	T	P	C	Category
1	EE3005	Digital Signal Processing	3	-	-	3	PT
2	EE3006	Power Systems - II	3	-	-	3	PT
3	EE3007	Power Electronics	3	-	-	3	PT
4		Elective - 3	3	-	-	3	PT
5		Elective - 4	3	-	-	3	PT
6	EE3008	Environmental Studies for Electrical Engineers	3	-	-	3	OT
7	EE3092	Electrical Machines Lab - II	-	-	3	2	PT
8	EE3093	Mini Project	-	-	3	2	PR
			18	**-**	**6**	**22**	**6**

LIST OF ELECTIVES – VITH SEMESTER

Sl. No	Code	Title	Credits
1	EE3031	Dynamic System Simulation	3
2	EE3032	Digital Control Systems	3
3	EE3033	Fuzzy Logic Systems	3
4	EE3034	Electrical Machine Design	3
5	EE3035	Biomedical Instrumentation	3
6	EE3036	Illumination Engineering	3
7	EE3037	Analog Filters	3
8	EE3038	Power Semiconductor Devices	3
9	EE3039	Advanced Processor Architecture and System Organization	3
10	EE3040	LT & HT Distribution Systems	3
11	EE3041	DC Drives	3
12	EE3042	Electrical System Design for Buildings	3

BRIEF SYLLABI

EE3005 DIGITAL SIGNAL PROCESSING

Pre-requisites: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Discrete-time signals and systems- linear shift - invariant systems – Properties of systems- representations- z transform and inverse z transforms; Transform Analysis of LTI Systems and Structures for DTS - Geometric construction for computation of the frequency response function from pole-zero plots- Linear systems with generalized linear phase- - basic structures for IIR and FIR systems; Digital filter design techniques and finite word length effects- Design of IIR and FIR filters- zero input limit cycles- Limit cycles due to overflow; The Discrete Fourier Transform - Representation of periodic sequences- linear convolution using DFT- FFT algorithms- DFT analysis of sinusoidal signals.

Total Hrs : 42 Hrs

EE3006 POWER SYSTEMS - II

Pre-requisites : None

L	T	P	C
3	0	0	3

Performance of transmission lines-Representation of power systems- load flow studies- HVDC Transmission and AC-DC load flow -Short circuit studies- Economic dispatch of thermal plants- implementation of Economic Dispatch and Automatic Generation Control- Introduction to deregulated power systems Power system stability studies.

Total Hrs: 42 Hrs

EE3007 POWER ELECTRONICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Power diodes - thyristors - gate triggering circuits - commutation circuits – IGBTs – MOSFETs - Controlled rectifiers using SCR - series, parallel and bridge inverters – PWM inverters - AC regulators - Cycloconverters - choppers - switching regulators - switched mode power supply - uninterruptible power supply units.

Total Hrs: 42 Hrs

EE3008 ENVIRONMENTAL STUDIES FOR ELECTRICAL ENGINEERS

Pre-requisites: None

L	T	P	C
3	0	0	3

Renewable and non-renewable resources - forest resources - use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forest and tribal people - water resources - use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - mineral resources - use and exploitation- environmental effects of extracting and using mineral resources, case studies- ecosystems - concept of an ecosystem - structure and function of an ecosystem introduction – definition - genetic, species and ecosystem diversity - bio geographical classification of India - environmental pollution - social issues and the environment - human population and the environment - population growth- variation among nations. - population explosion – family welfare program - field work

Total Hrs: 42 Hrs

EE 3031 DYNAMIC SYSTEM SIMULATION

Prerequisite: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Simulation of systems using Computers: Study of popular Simulation Tools- Text based programming-Integrated Programming Environments-Case studies for typical systems.

Blockset based simulation techniques- Case studies for typical systems- Simulation of Power Electronic Circuits, Machines and Drives- Circuit Simulation and Systems Simulation approaches-Development of generalized machine models for induction motor. -

Introduction to Random Processes and Stochastic Systems Theory

Total Hrs: 42 Hrs

EE3032 DIGITAL CONTROL SYSTEMS

Pre-requisite: EE3002 Control Systems I

L	T	P	C
3	0	0	3

Basic digital control system-Sample and Hold-Mapping between s-domain and z-domain-Principles of discretisation- Pulse transfer function- Modified z-transform- Multi-rate discrete data systems-Steady state performance- Jury's stability test – Robustness and sensitivity-Root locus- Polar plots-Nyquist stability criterion-Bode plot- Bilinear transformation method and Routh stability criterion on the r-plane – Design of compensators using root locus and bilinear transformation-Design of PID controllers- Dead-beat response design- State variable model of discrete data systems - Controllability, Observability, stability and reachability- Loss of controllability and observability due to sampling -Pole placement design using state feedback for SISO systems-Computer based simulation.

Total Hrs: 42 Hrs

EE 3033 FUZZY LOGIC SYSTEMS

Pre-requisite: None

L	T	P	C
3	0	0	3

Theory of Fuzzy Sets and fuzzy relations: Fuzzification and De-fuzzification : Formation of Fuzzy Rule Base-defuzzification methods -Fuzzy Logic : fuzzy rule based systems - approximate reasoning - canonical rule forms - decomposition of compound rules - fuzzy inference systems- Mamdani and Takagi-Sugeno fuzzy models- fuzzy control models-P-1-D like fuzzy control rules – implementation. Computer based simulation-Language based programming in C/C++-Use of Simulation Tools -Fuzzy nonlinear simulation- fuzzy classification - clustering – fuzzy pattern recognition - fuzzy control systems- fuzzy optimization - case studies – Fuzzy Logic combined with Neural Networks and Genetic Algorithms-Soft Computing Techniques- Fuzzy measures (brief introduction only).

Total Hrs: 42 Hrs

EE3034 ELECTRICAL MACHINE DESIGN

Prerequisite: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

DC machines - output equation - main dimensions - choice of specific loadings, speed and number of poles - design of various parts - Carter's coefficient - design examples - Transformers - output equation of single phase and three phase power transformers - main dimensions - choice of specific loadings - design of various parts -

prediction of various quantities and equivalent circuit based on design data - design examples - alternators - output equation of salient pole and turbo alternators - main dimensions - choice of specific loadings, speed and number of poles - design of various parts - prediction of regulation and the characteristics based on design data - design examples - induction machines - output equation - main dimensions - choice of specific loadings - design of various parts - prediction of various quantities and equivalent circuit based on design data - design examples.
Total Hrs : 42 Hrs

EE 3035 BIOMEDICAL INSTRUMENTATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Introduction to electrophysiology – action potential – transducers for biomedical - heart and cardiovascular system –blood pressure measurement - plethysmography - heart lung machine - ECG – Eindhoven 's law - 12 lead system – cardiac pace maker –defibrillator -EMG – introduction to nervous system and brain -EEG –

Introduction to intensive care monitoring –patient monitoring instruments –organization of hospital for patient care monitoring – respiratory physiology – measurements in respiratory system –respiratory therapy equipments – instrumentation for sensory measurement and behavioral studies – ultrasonics in medicine

Lasers in medicine - X ray and radio isotopes – radio therapy equipment -safety and dosage

Renal physiology

Total Hrs : 42 Hrs

EE3036 ILLUMINATION ENGINEERING

Pre-requisites : None

L	T	P	C
3	0	0	3

Need for good Illumination, Radiation, Eye and Vision , Laws of Illumination, Electric light sources and their operating characteristics, Entities in the illumination systems and their units, measurement of illumination- determination of total luminous flux emitted by different sources, Design of lighting systems- Interior Lighting -Sports Lighting -Road Lighting -Street lighting-Factory outdoor lighting- Flood lighting, Maintenance of lighting system and Lighting Calculations considering day light. Design of Energy efficient lighting systems.

Total Hrs : 42 Hrs

EE3037 ANALOG FILTERS

Pre-requisites: EE2001 Signals & Systems, EE2004 Basic Electronic Circuits,

EE2005 Circuits & Networks, EE2008 Analog Electronic Circuits & Systems

L	T	P	C
3	0	0	3

Review of continuous time LTI systems – Categories of Filters- The Filter approximation problem: - Butterworth Approximation- Chebyshev and Inverse Chebyshev Approximations- Elliptic Approximation- Bessel approximation- Phase and Group delay characteristics of approximation functions-delay equalizer functions

Passive filters -Higher order filters- network functions-synthesis of higher order passive filters. Singly and doubly terminated LC ladders. Limitations of Passive filters

Active Filters Single OPAMP Biquads - Analysis and design of LP, HP and BP Filter with second order response. Sensitivity Analysis of Single OPAMP Filters. Analysis and design of various multiple OPAMP filters – Compensation -Inductor Simulation, Antoniou Gyrators, LP,HP,BP and BE Filters using Antoniou

Gyrators. -Structure for LP, HP, BP and BE SC Filters, Basic ideas of method of realization of higher order filters. Synthesis of LC ladder Networks using gyrators

Total Hrs : 42 Hrs

EE3038: POWER SEMICONDUCTOR DEVICES

Pre-requisite: None

L	T	P	C
3	0	0	3

Power Diode: Basic Structure and I-V Characteristics. Thyristor: Basic Structure . V-I Characteristics. DIAC: Basic Structure and operation . V-I Characteristics . Ratings TRIAC: Basic Structure and operation . V-I Characteristics . Ratings . Snubber Requirements. Gate Turnoff Thyristor (GTO): Basic Structure and Operation Power BJT: Basic Structure and I-V Characteristics . Power MOSFET: Basic Structure . V-I Characteristics Insulated Gate Bipolar Junction Transistor (IGBT): Basic Structure and Operation.

Total Hrs: 42 Hrs

EE3039 ADVANCED PROCESSOR ARCHITECTURE & SYSTEM ORGANISATION

Pre-requisites: EE3001 Microprocessors & Microcontrollers

L	T	P	C
3	0	0	3

Basics of Computer System – Micro Controllers – Introduction to different manufacture's microcontrollers – dsPIC as a tool to learn modern microcontrollers – Simulation using MPLAB IDE – Applications – Relay, Keyboard, LED / LCD display interfacing – Motor Control – Measurement systems.

Total Hrs : 42 Hrs

EE3040 LT & HT DISTRIBUTION SYSTEMS

Pre-requisites : None

Power system-general concepts, Load and Energy forecasting, Power system analysis, Optimization of distribution system-network cost modeling-economic loading of distribution transformers. Distribution system reliability, Consumer services, Tariffs-costing and pricing, Overhead and underground lines-optimum design considerations, Power capacitors - HT and LT capacitor installation requirements, Distribution System Design, Electrical Safety and Earthing Practices, Lightning protection, Distribution Automation System -SCADA systems and Automation

Total Hrs : 42 Hrs

EE3041 DC DRIVES

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Introduction to Drives – Modelling of DC machines - Theory of operation – Induced EMF – Equivalent circuit and electromagnetic torque – Elecrtomechanical modeling – state space modeling – Phase controlled DC motor Drives - Field Control – Armature Control – Steady state analysis of Three phase converter controlled DC motor drive – DC motor drive with field weakening. Harmonics and Associated problems – Effect of field weakening - Chopper Controlled DC motor Drive - Steady state analysis of chopper controlled DC motor drive- Torque pulsations.

Total Hrs : 42 Hrs

EE3042 ELECTRICAL SYSTEM DESIGN FOR BUILDINGS

Pre-requisites : None

L	T	P	C
3	0	0	3

Electrical Installations: general requirements, design considerations, testing, estimating and costing - design of panel boards – design and estimation of service connections – design and safety aspects of residential buildings- Illumination schemes- design of lighting for various purposes- Electrical system design, estimation and costing of commercial buildings, hospitals, recreational and assembly buildings, cinema theatres, small industries, substations- Design of earthing system.

Total Hrs: 42 Hrs

EE3092 ELECTRICAL MACHINES LAB II

Prerequisite: EE3003 Electrical Machines II

L	T	P	C
0	0	3	2

No-load and Blocked-Rotor tests and load tests on Three-phase and Single-phase Induction Motors, Speed control of Induction Motor, Regulation studies on Salient Pole and Non-Salient Pole Synchronous Machines, Synchronisation and V-Curves of a Synchronous Machine

Total Hrs : 42 Hrs

DETAILED SYLLABI

EE3005 DIGITAL SIGNAL PROCESSING

Pre-requisites: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: **(10 Hrs)**

Discrete-time signals and systems: Discrete-time signals - sequences - Discrete-time systems- linear shift - invariant systems - stability and causality - difference equations - frequency domain representations – Review of Fourier transform and its properties - sampling of continuous - time signals – Spectral characteristics - z transform - inverse z transforms .

Module 2: **(10 Hrs)**

Transform Analysis of LTI Systems and Structures for DTS: Frequency response for rational system functions- Geometric construction for computation of the frequency response function from pole-zero plots- All pass systems-minimum phase systems-Linear systems with generalized linear phase characteristics- basic structures for IIR and FIR systems- Direct forms- cascade forms- parallel forms.

Module 3: **(12 Hrs)**

Digital filter design techniques and finite wordlength effects: Design of IIR filters from analog filters - analog Butterworth function for various frequency selective filters- analog to digital transformation - backward - difference and forward - difference approximations - impulse invariant transformation - bilinear transformation - prewarping - design examples - properties of FIR filters - design of FIR filters using windows - comparison of IIR and FIR filters - finite word length effect in DSP- zero-input limit cycles in fixed point realizations of IIR digital filters-Limit cycles due to overflow.

Module 4: **(10 Hrs)**

The Discrete Fourier Transform : Representation of periodic sequences - properties of discrete Fourier series - discrete Fourier transforms - properties of DFT - linear convolution using DFT - overlap - add method - overlap - save method - FFT - Radix2 DIT FFT algorithm - Radix2 DIF FFT algorithm - butterfly structure - bit reversed order - in - place computations-Fourier analysis of signals using the DFT .

Text/Reference Books:

1. Alan V . Oppenheim, Ronald W. Schafer, .Discrete-Time Signal Processing., Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
2. Sanjit K Mitra, .Digital Signal Processing: A computer-based approach. ,Tata McGrow-Hill edition .1998
3. John G. Proakis, and Dimitris G. Manolakis, .Digital Signal Processing.(Fourth Edition), Pearson Prentice Hall of India Pvt. Ltd, New Delhi, 2007
4. Emmanuel C. Ifeachor, Barrie W. Jervis , .Digital Signal Processing-A practical Approach., Addison Wesley Publishers Ltd.,1993
5. Abraham Peled and Bede Liu, Digital Signal Processing ,Theory, Design and Implementation, John Wiley and Sons,Inc., 1976
6. Haykin and Van Veen, Signals and Systems, (second edition), John Wiley and sons, Inc.,2003.

EE3006 POWER SYSTEMS - II

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: **(12 Hrs)**

Performance of transmission lines - calculation of transmission line inductance and capacitance - GMD and GMR - bundled conductors - transposition - ABCD constants - effect of capacitance - nominal T and π methods of calculations -power flow through a transmission line. Methods of voltage control

Representation of power systems - per unit quantities - Y-bus and Z-bus matrices - load flow studies:-Gauss-Seidal- Newton Raphson and fast decoupled methods - line loss computation – HVDC Transmission and AC-DC load flow

Module 2: **(10 Hrs)**

Short circuit studies - faults on power systems - short circuit capacity of a bus and circuit breaker ratings-current limiting reactor- sequence impedances and sequence network - symmetrical component methods of analysis of unsymmetrical faults at the terminals of an unloaded generator – Z bus building algorithm-fault analysis using Z-bus

Module 3: **(10 Hrs)**

Economic dispatch of thermal plants. B-coefficient - optimal load flow solution –unit commitment-speed governing of turbo generator - load sharing and governor characteristics-load frequency control of single and multi area systems - implementation of Economic Dispatch and Automatic Generation Control - automatic voltage regulation - EMS. SCADA, hydro thermal scheduling.

Module 4: **(10 Hrs)**

Power system stability studies - electrical stiffness - swing equation - inertia constant - equal area criterion - multi machine stability analysis - factors affecting stability-Voltage stability problem: causes and improvement methods-introduction to power system security and reliability-deregulated power systems.

Text/ Reference Books:

1. Stevenson J V, William D, “Elements of Power System Analysis”, McGraw Hill, 1988.
2. D.P. Kothari & 1.J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill, 2007.
3. A.K. Mahalanabis, “Computer Aided Power System Analysis & Control”, Tata McGraw Hill, 1991
4. Arthur R Bergen, Vijay Vittal, “Power system Analysis”, Pearson Education (Singapore) Pte, Ltd., 2004
5. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2003.
6. J Arrilaga, C P Arnold, B J Harker, “Computer Modelling of Electric Power Systems”
7. Elgerd olleI, “Electric Energy Sytems Theory- An Introduction”, Tata Mc Graw Hill, 2ed. 1995.
8. Wadhwa C L, “Electrical Power Systems”, New Age Publication, 3ed., 2002
9. LOI LEI LAI, “Power system restructuring and deregulation”, John Wiley & sons, 2002.
10. Antonio Gomez-Exposito, Antonio j.conejo & Claudio canizares, “Electric Energy systems analysis and operation”, CRP press, 2009.

EE3007 POWER ELECTRONICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: Power Semiconductor Switches (12 Hrs)

Power diodes - Basic structure and V-I characteristics - various types - **DIACs** – Basic structure and V-I characteristics – **TRIACs** - Basic structure and V-I characteristics -**Thyristors** - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit using UJT - methods of turning off - commutation circuits. **IGBTs -** Basic structure and V-I characteristics. **MOSFETs -** Basic structure and V-I characteristics

Module 2: Rectifiers (11 Hrs)

Line frequency phase controlled rectifiers using SCR

Single Phase – Half wave rectifier with R and RL loads – Full wave half controlled and fully controlled converters with continuous and constant currents - Input side harmonics and power factor - Effect of source inductance

Three Phase - Half wave rectifier with R and RL loads - Full wave fully controlled converters with continuous and constant currents

Module 3: Inverters & Cycloconverters (10 Hrs)

Inverters – Single phase inverters – series, parallel and bridge inverters. Single Phase Pulse Width Modulated (PWM) inverters – Basic circuit and operation.

AC regulators - single phase ac regulator with R and RL loads - sequence control of ac regulators - single phase to single phase cycloconverters - basic principle of operation.

Module 4: DC – DC Converters (9 Hrs)

Choppers - principle of operation - step-up and step-down choppers.

Switching regulators - Buck regulators - Boost regulators - Buck-boost regulators - Switched mode power supply - principle of operation and analysis

Text/Reference Books:

1. Ned Mohan, Power Electronics., John Wiley and Sons, 2nd edition, 1995.
2. Rashid, Power Electronics, Circuits Devices and Applications, Pearson Education, 3rd edition, 2004.
3. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
4. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.
5. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

EE3008 ENVIRONMENTAL STUDIES FOR ELECTRICAL ENGINEERS

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Unit 1 : Multidisciplinary nature of environmental studies (2 hrs)
Definition, scope and importance , Need for public awareness.
Unit 2 : Natural Resources : (7 hrs)
Renewable and non-renewable resources :
Natural resources and associated problems. a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources : Use and over-utilization of surface and ground water,
floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
Role of an individual in conservation of natural resources-Equitable use of resources for sustainable lifestyles.

Unit 3 : Ecosystems (5 hrs)
Concept of an ecosystem. - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramid- Introduction, types, characteristic features, structure and function of the following ecosystem :- (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
Unit 4 : Biodiversity and its conservation (6 hrs)
Introduction – Definition : genetic, species and ecosystem diversity. - Biogeographical classification of India - Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, National and local levels - India as a mega-diversity nation - Hot-spots of biodiversity. - Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts. - Endangered and endemic species of India - Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
Unit 5 : Environmental Pollution (6 hrs)
Definition - Cause, effects and control measures of :- (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards - Solid waste Management : Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Pollution case studies. - Disasters management : floods, earthquake, cyclone and landslides.
Unit 6 : Social Issues and the Environment (6 hrs)
From Unsustainable to Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, watershed management - Resettlement and rahabilitation of people; its problems and concerns. Case Studies - Environmental ethics : Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear
accidents and holocaust. Case Studies - Wasteland reclamation -Consumerism and waste products - Environment Protection Act -Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation - Public awareness.
Unit 7 : Human Population and the Environment (5 hrs)
Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case Studies.

Unit 8 : Field work (5 hrs)

Visit to a local area to document environmental assets- river/forest/grassland/hill/mountain - Visit to a local polluted site-Urban/Rural/Industrial/Agricultural - Study of common plants, insects, birds -Study of simple ecosystems-pond, river, hill slopes, etc.

Text/Reference Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment (R)
8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev.,
9. Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
10. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural
11. History Society, Bombay (R)
12. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
13. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
14. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
15. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
16. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
17. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
18. Rao M N. & Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.
19. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
20. Survey of the Environment, The Hindu (M)
21. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
22. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines,
23. Compliances and Standards, Vol 1 and 2, Enviro Media (R)
24. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
25. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

(M) Magazine

(R) Reference

(TB) Textbook

EE 3031 DYNAMIC SYSTEM SIMULATION

Prerequisite: EE2001 Signals & Systems

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: **(11 Hrs)**

Simulation of systems using Computers: Study of popular Simulation Tools- Text based programming-Integrated Programming Environments-Case studies for typical systems Computer simulation of continuous time dynamic systems using transfer function models- electromechanical hydraulic and pneumatic systems-Simulation of discrete time and digital control systems-State Space Models-State feedback Control.

Module 2: **(11 Hrs)**

Blockset based simulation techniques- Case studies for typical systems- Computer simulation of continuous time dynamic systems using transfer function models- electromechanical hydraulic and pneumatic systems Simulation of discrete time and digital control systems.

Module 3: **(10 Hrs)**

Simulation of Power Electronic Circuits, Machines and Drives- Circuit Simulation and Systems Simulation approaches-Development of generalized machine models for induction motor. Simulation of Ward Leonard system of speed control. Simulation of induction motor driven from inverters.

Module 4: **(10 Hrs)**

Introduction to Random Processes and Stochastic Systems Theory : Time Series Methods- Simulation of AR, MA, ARMA processes- Outliers- Statistical models in simulation . discrete and continuous distributions- Poisson processes- empirical distributions- queuing models- characteristics of queuing systems- performance measures-Markovian models- steady state behaviour of infinite population Markov models-single server queues with Poisson arrivals- Steady state behavior of finite population models-Developing Random Sequences with different distributions like Gaussian, Cauchy, Laplace etc from Uniform random numbers-Discrete Even Systems

Text/Reference Books:

1. Narsingh Deo, . System Simulation with Digital Computer, Prentice Hall India, 1989
2. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, *Control System Design*, Prentice Hall India, 2003
3. Richard C. Dorf and Robert H Bishop, *Modern Control Systems*, 8th Ed., Addison Wesley, 1998.
4. Karl J. Aström, Björn Wittenmark, *Computer Controlled Systems: Theory and Design*, 3rd Ed. Prentice Hall, 1997.
5. Douglas M. Considine, *Process/Industrial Instruments & Control Handbook*, 4th Ed., McGrawHill, 1993.
6. Jai P. Agarwal, *Power Electronic Systems: Theory & Design*, Pearson Education Asia, 2001.
7. P.C. Sen, *Principles of Electrical Machines & Power Electronics*, John Wiley, 2003.
8. Louis G Birta and Gilber Arbez, Modelling and Simulation(Exploring Dynamic System behavior) Springer Verlag, 2007

EE3032 DIGITAL CONTROL SYSTEMS

Pre-requisite: EE3002 Control Systems I

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: (**11 Hrs**)

Basic digital control system- Examples - mathematical model-ZOH and FOH- choice of sampling rate-principles of discretisation-Mapping between s-domain and z-domain-Pulse transfer function- Different configurations for the design- Modified z-transform- Multi-rate discrete data systems.

Module 2: **(11 Hrs)**

Time responses of discrete data systems- Correlation between time response and root locations in the z-plane-Steady state performance- Disturbance Rejection- Robustness and Sensitivity -Jury's stability test – Routh stability criterion on the r-plane -Root locus- Polar plots-Nyquist stability criterion- Bode plot- Bilinear transformation method .

Module 3: **(10 Hrs)**

Cascade compensators using Root Locus- Design of PID controllers by using bilinear transformation- Digital controller design using bilinear transformation- Dead-beat response design- Deadbeat controller without and with prescribed manipulated variable-Choice of sample time for deadbeat controller-Realization of digital controllers- Computer based simulation.

Module 4: **(10 Hrs)**

State variable model of discrete data systems with S/H devices- State transition equations- state diagrams-Transfer function- Transformation to Jordan canonical form and phase variable form- Computation of state transition matrix using Cayley-Hamilton theorem and z-transform method- Response between sampling instants-Controllability, Observability, stabilizability and reachability- Loss of controllability and observability due to sampling- Pole placement design using state feedback for SISO systems- Computer based simulation.

Text/Reference Books:

1. M.Gopal,Digital control and State Variable methods, Tata McGraw –Hill , 1997
2. B.C.Kuo, Digital Control Systems, 2nd Ed., Oxford University Press,1992.
3. Constantine H. Houpis and Gary B. Lamont, Digital control systems Theory, hardware software, Mc-Graw Hill Book Company, 1985.
4. R.Isermann, Digital control systems, Volume 1, Fundamentals , Deterministic control,(2nd revised edition),Springer Verlag, 1989.
5. R.G.Jacquot, Modern digital control systems, (second edition),Marcel Dekker, Inc., 1995.
6. Philips and Nagle, Digital control system analysis and design, Prentice Hall, 1984.
7. G.F.Franklin, J.David Powell and M.Workman,Digital Control of Dynamic Systems, 3rd Ed.,,Addison Wesley, 2000.

EE 3033 FUZZY LOGIC SYSTEMS

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: **(12 Hrs)**

Theory of Fuzzy Sets and fuzzy relations: Fuzzy Reasoning-Fuzzy Rules-Fuzziness compared to randomness-Introduction - Classical sets and fuzzy sets-operations on both- properties of fuzzy sets-classical relations and fuzzy relations- cardinality of fuzzy relations-Fuzzy Cartesian product and composition–fuzzy tolerance and equivalence relations- value assignments - cosine amplitude-max-min method.

Module 2: **(12 Hrs)**

Fuzzification and De-fuzzification : Formation of Fuzzy Rule Base-Membership functions - features -standard forms –fuzzification - membership value assignments - intuition – inference-rank ordering - angular fuzzy sets - inductive reasoning -fuzzy to crisp conversion – lambda/alpha cuts for fuzzy sets and fuzzy relations - defuzzification methods.

Module 3: **(11 Hrs)**

Fuzzy Logic : Classical logic and fuzzy logic –fuzzy rule based systems - approximate reasoning - canonical rule forms - decomposition of compound rules - likelihood and truth classification - aggregation of fuzzy rules – fuzzy inference systems- Mamdani and Takagi-Sugeno fuzzy models- fuzzy control models-P-1-D like fuzzy control rules – implementation. Computer based simulation-Language based programming in C/C++-Use of Simulation Tools.

Module 4: **(7 Hrs)**

Fuzzy nonlinear simulation- fuzzy classification - clustering – fuzzy pattern recognition - fuzzy control systems- fuzzy optimization - case studies – Fuzzy Logic combined with Neural Networks and Genetic Algorithms-Soft Computing Techniques- Fuzzy measures (brief introduction only).

Text/Reference Books:

1. Timothy J Ross, *Fuzzy Logic with Engineering Applications*, McGraw Hill, 2007.
2. Guanrong Chen & Trung Tat Pham Introduction to Fuzzy Systems, Chapman & hall /CRC, 2006
3. Driankov D., Hellendoorn H., Reinfrank M, *An Introduction to Fuzzy Control*., Narosa Publications ,1993.
4. Robert Babuska, *Fuzzy Modeling for Control*, International Series in Intelligent Technologies, Kluwer Academic Publications, 1998
5. Ronald R Yager and Dimitar P Filev, *Essentials of Fuzzy Modelling & Control*., John Wiley & Sons, Inc, 2002.
6. J.-S.R.Jang, C.-T.Sun,E.Mizutani, *Neuro-Fuzzy and Soft Computing*, Prentice Hall, 1997.
7. B.Kosko, *Fuzzy Engineering*, Prentice Hall, 1997

EE3034 ELECTRICAL MACHINE DESIGN

Prerequisite: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: DC machines **(11 Hrs)**

Output equation - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system, commutator, interpoles, compensating winding and brushes - Carter's coefficient - real and apparent flux density - design examples.

Module 2: Transformers **(10 Hrs)**

Output equation of single phase and three phase power transformers - main dimensions - choice of specific electric and magnetic loadings - design of core, LV winding, HV winding, tank and cooling tubes - prediction of no load current, forces on winding during short circuit, leakage reactance and equivalent circuit based on design data - design examples.

Module 3: Alternators **(10 Hrs)**

Output equation of salient pole and turbo alternators - main dimensions - choice of specific electric and magnetic loadings - choice of speed and number of poles - design of armature conductors, slots and winding - design of air-gap, field system and damper winding - prediction of open circuit characteristics and regulation of the alternator based on design data - design examples.

Module 4: Induction machines **(11 Hrs)**

Output equation - main dimensions - choice of specific electric and magnetic loadings - design of stator and rotor windings, stator and rotor slots and air-gap of slip ring and squirrel cage motors - calculation of rotor bar and end ring currents in cage rotor - calculation of equivalent circuit parameters and prediction of magnetising current based on design data - design examples

Text/Reference Books:

1. Clayton & Hancock, Performance & Design Of DC Machines, CBS, 3rd edition, 2001
2. Sawhney, Electrical Machine Design, Educational Publishers and Distributors, 1998.
3. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.

EE 3035 BIOMEDICAL INSTRUMENTATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: **(11 Hrs)**

Introduction to electrophysiology – action potential – transducers for biomedical applications -electrodes – mono polar and bipolar recording - heart and cardiovascular system –blood pressure measurement – characteristics of blood flow-electromagnetic and ultrasonic blood flow meters- indicator dilution technique - plethysmography - sounds of the heart – blood pumps – heart lung machine - ECG – Eindhoven 's law - 12 lead system – cardiac pace maker –defibrillator -EMG – introduction to nervous system and brain -EEG –

Module 2: **(11 Hrs)**

Introduction to intensive care monitoring –patient monitoring instruments –organization of hospital for patient care monitoring – respiratory physiology – measurements in respiratory system –respiratory therapy equipments – instrumentation for sensory measurement and behavioral studies – ultrasonics in medicine

Module 3: **(10 Hrs)**

Lasers in medicine - X ray and radio isotopes – radio therapy equipment -safety and dosage

Module 4: **(10 Hrs)**

Renal physiology – membranes for haemodialysis – haemodialysis machines- lithotripters –

Measurement of p^{H}, $p^{CO}{}_{2}$ and $p^{O}{}_{2}$

Text/Reference Books:

1. Hand book of Biomedical instrumentation By RS Khandpur, Tata McGrawHill , 2007
2. Biomedical instrumentation and measurements By Leslie Cromwell, Fred J Weibell
   Erich A Pfeiffer , Pearson 2008
3. Principles of Applied biomedical instrumentation , Geddes & Baker , 3rd edition John Wiley & Sons

EE3036 ILLUMINATION ENGINEERING

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: **(9 Hrs)**

Introduction : State the need for Illumination, Define good Illumination, Radiation - Eye and Vision - The purkinje effect- Laws of Illumination –Candela- Frechner's law - Inverse Square Law - Lambert's Cosine Law of Incidence Photometry and spectrophotometry .

Module 2: **(10 Hrs)**

Electric light sources and their operating characteristics: Incandescent lamps: ratings, operating characteristics- vapor lamps- mercury vapor lamps- sodium vapor lamps-Fluorescent lamps: fundamentals, ratings, cathode types- starters- ballasts- operating characteristics- CFL- Bulb Temperature Vs Light output - Lumen Maintenance Curve

Module 3: **(11 Hrs)**

Entities in the illumination systems and their units: Illumination, intensity, brightness, soild angle relationships, luminous flux-luminosity-measurement of illumination- determination of total luminous flux emitted by a plane source, circular disc source, rectangular source, strip source.

Module 4: **(12 Hrs)**

Design of lighting systems- Interior Lighting -Sports Lighting -Road Lighting -Street lighting-Factory outdoor lighting- Flood lighting -Maintenance of lighting system and Lighting Calculations considering day light. Design of Energy efficient lighting systems.

Text/Reference Books:

1. Prathab H, “Art and Science of Utilization of Electrical Energy”, Dhanapat Rai & Sons, Delhi
2. Steffy G, “Architectural Lighting Design”, 3rd Edition, John Wiley & Sons, 2008
3. Boast W.B, Illumination Engineering, Mc Graw Hill Book Company, 1953.
4. Cotton H, Principles of Illumination, John Wiley and Sons, 1960.

EE3037 ANALOG FILTERS

Pre-requisites: EE2001 Signals & Systems, EE2004 Basic Electronic Circuits,

EE2005 Circuits & Networks, EE2008 Analog Electronic Circuits & Systems

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: **(12 Hrs)**

Review of continuous time LTI systems – frequency domain representation of continuous time signals. Laplace transform- inverse Laplace transform- properties.

Categories of Filters- LP, HP, BP, BE and All Pass Filters- Second Order s-domain equations in each case and their pole-zero plots.

The Filter approximation problem: - Butterworth Approximation- Chebyshev and Inverse Chebyshev Approximations- Elliptic Approximation- Bessel approximation- Phase and Group delay characteristics of approximation functions-delay equalizer functions

Module 2: **(10 Hrs)**

Passive filters Realization of first order First Order LP, HP, BP, All Pass Filters- frequency transformation.

Higher order filters- network functions-synthesis of higher order passive filters. Singly and doubly terminated LC ladders. Limitations of Passive filters

Module 3: **(11 Hrs)**

Active Filters Single OPAMP Biquads : First Order LP,HP,BP, All Pass Filters- Biquad Topologies, Analysis and Design of Single OPAMP Biquads with finite gain . Analysis and design of LP, HP and BP Filter with second order response. Sensitivity Analysis of Single OPAMP Filters. Analysis and design of various multiple OPAMP filters - Compensation

Module 4: **(9 Hrs)**

Inductor Simulation, Antoniou Gyrators, LP,HP,BP and BE Filters using Antoniou Gyrators**.**

Structure for LP, HP, BP and BE SC Filters, Basic ideas of method of realization of higher order filters. Synthesis of LC ladder Networks using gyrators

Text /Reference books:

1. G. Daryanani, Digital and Analog Communication Systems, John Wiley and Sons, 1976
2. M.E Van Valkenberg, Analog Filter Design, Prentice Hall of India, 2004.
3. M.E Van Valkenberg , Design of Analog Filters, Oxford University Press,2001
4. L.P Huelsman, Introduction to the Theory and Design of Active Filters, McGraw Hill, 1980
5. Roubik Gregorian and Gabor C, Analog MOS Integrated Circuits for Signal Processing, John Wiley and Sons, 1986
6. Kendall L. Su, Analog Filters, Kluwer academic publishers, 1996
7. Wai-Kai Chen, Passive and active filters, John Wiley & Sons, 1986

EE3038: POWER SEMICONDUCTOR DEVICES

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: **(11 Hrs)**

Power Diode: Basic Structure and 1-V Characteristics . Breakdown Voltages and Control . On State Losses . Switching Characteristics . Turn on Transient . Turn off Transient . Reverse Recovery Transient . Schottky Diodes . Snubber Requirements for Diodes and Diode Snubbers.

Thyristor: Basic Structure . V-1 Characteristics . Turn on Process . On State operation . Turn off process . Switching Characteristics .Turn on Transient and di/dt limitations . Turn off Transient . Turn off time and reapplied dv/dt limitations . Ratings of Thyristors . Snubber Requirements and Snubber Design.

Module 2: **(9 Hrs)**

DIAC: Basic Structure and operation . V-1 Characteristics . Ratings

TRIAC: Basic Structure and operation . V-1 Characteristics . Ratings . Snubber Requirements.

Gate Turnoff Thyristor (GTO): Basic Structure and Operation . GTO Switching Characteristics . GTO Turn on Transient . GTO Turn off Transient . Minimum ON and OFF State times .Maximum Controllable Anode Current . Overcurrent protection of GTOs

Module 3: **(12 Hrs)**

Power BJT: Basic Structure and 1-V Characteristics . Breakdown Voltages and Control . Second Breakdown and its Control- FBSOA and RBSOA Curves - On State Losses . Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications . Turn on Transient . Turn off Transient . Storage Time .Base Drive Requirements . Switching Losses . Device Protection- Snubber Requirements for BJTs and Snubber Design - Switching Aids.

Power MOSFET: Basic Structure . V-1 Characteristics . Turn on Process . On State operation . Turn off process . Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications - Turn on Transient and di/dt limitations . Turn off Transient . Turn off time . Switching Losses . Effect of Reverse Recovery Transients on Switching Stresses and Losses - dv/dt limitations . Gating Requirements . Gate Charge - Ratings of MOSFETs. FBSOA and RBSOA Curves . Device Protection -Snubber Requirements .

Module 4: **(10 Hrs)**

Insulated Gate Bipolar Transistor (IGBT): Basic Structure and Operation .Latch up IGBT Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications - IGBT Turn on Transient . IGBT Turn off Transient- Current Tailing - Ratings of MOSFETs. FBSOA and RBSOA Curves . Switching Losses - Minimum ON and OFF State times - Switching Frequency Capability - Overcurrent protection of IGBTs . Short Circuit Protection . Snubber Requirements and Snubber Design. New power semiconductor devices.

Text/Reference Books:

1. Ned Mohan et.al ,"Power Electronics",John Wiley and Sons,2006
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc.,1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004.
4. V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications", John Wiley & Sons1994.99

EE3039 ADVANCED PROCESSOR ARCHITECTURE & SYSTEM ORGANISATION

Pre-requisites: EE3001 Microprocessors & Microcontrollers

L	T	P	C
3	0	0	3

Total Hrs : 42 Hrs

Module 1: **(11 Hrs)**

Basic Concepts of Microprocessors, Different Architectures of Microprocessors. 8051 Microcontroller-Hardware, 1/O Pins, Ports and Circuits, External Memory, Counters and Timers, Serial Data Input/ Output, Interrupts, Assembly Language Programming of 8051.

Module 2: **(11 Hrs)**

8086 Hardware Details, Memory Organization and Addressing Modes, System Bus Structure – Minimum Mode and Maximum Mode, Interrupt Priority Management, System Bus Timing, Multiprocessor Configuration

Module 3: **(10 Hrs)**

Design of 8086 based system, Architecture of 80286, 80386, Development of Personal Computers.

Module 4: **(10 Hrs)**

Processor Types and Instruction Sets , Microcode , Protection and Processor Modes, Physical Memory , Virtual Memory, Caches, Bus Architecture , Parallelism and Pipelining , Performance Assessing of processors,

Text/Reference Books:

1. Brey B.B., The Intel Microprocessors - Architecture, Programming & Interfacing, Prentice Hall, 6th edition, 2004.
2. Liu Y.C. & Gibsen G.A., Microcomputer System: The 8086/8088 Family, Architecture Programming and Design , Prentice Hall of India, 2nd edition,2004 .
3. Ayala K.J., The 8051 Micro controller, Architecture, Programming and Applications, Penram International Publishing (India),2nd edition,1996.
4. Ayala K.J., The 8086 Microprocessor: Programming and Interfacing The PC, Penram International Publishing (India),1995.
5. Trebel, Walter A Singh, Avtar, 8088 and 8086 microprocessors, Programming Interfacing, Software, Hardware and Aplications , Pearson Education , 4th edition, 2004.
6. Douglas E Comer, Essentials of Computer Architecture , Pearson Education,2005.
7. Pattersen D.A. & Hennesy J.L., Computer Organization and Design: The Hardware/ Software Interface, Harcourt Asia Pvt Ltd (Morgan Kaufman), 2nd edition, 2002.
8. Heuring V.P. & Jordan H.F., Computer System Design and Architecture, Addison Wesle Hamacher, Vranesic & Zaky, Computer Organisation, McGraw Hill,2002

EE3040 LT & HT DISTRIBUTION SYSTEMS

Pre-requisites : None

Total Hrs : 42 Hrs

L	P	T	C
3	0	0	3

Module 1: **(11 Hrs)**

Power system-general concepts-distribution of power, load and energy forecasting-factors in power system loading , Power system analysis-load flow-fault studies-voltage control, Optimization of distribution system-network cost modeling-economic loading of distribution transformers. Distribution system reliability-reliability assessment techniques

Module 2: **(10 Hrs)**

Consumer services-maximum demand, diversity and load factor-consumer load control for power shortages, Tariffs-costing and pricing –economically efficient tariff structure.

Overhead and underground lines-optimum design considerations, Power capacitors-size of capacitor for power factor improvement- HT and LT capacitor installation requirements.

Module 3: **(10 Hrs)**

Distribution System Design- Electrical Design Aspects of Industrial, Commercials Buildings-

Design, estimation and costing of outdoor and indoor Substations, Electrical Safety and Earthing Practices at various voltage levels- Lightning protection.-Regulations and standards.

Module 4: **(11 Hrs)**

Distribution Automation System : Necessity, System Control Hierarchy- Basic Architecture and implementation Strategies for SCADA and DAC systems -Basic Distribution Management System Functions.

Communication Systems for Control and Automation- Wireless and wired Communications- SCADA and DAC communication Protocols, Architectures and user interface

Text/References:

1. Turan Gonen, “Electric Power Distribution system Engineering” Mc Graw-hill ,Inc,1987
2. A.S. Pabla, “ Electric Power Distribution systems” Tata Mc Graw-hill Publishing company limited, 4th edition, 1997.
3. Alexander Eigeles Emanuel, “Power Definitions and the Physical Mechanism of Power Flow”, John Wiley & Sons, October 2009.
4. “Handbook of International Electrical Safety Practices”, John Wiley & Sons, PERI June 2009.
5. Ali A. Chowdhury, Don O. Koval, “Power distribution system reliability-Practical methods and applications” John Wiley & sons Inc., *IEEE Press* 2009
6. Richard E.Brown, “Electric power distribution reliability” Taylor & Francis Group,LLC,2009.
7. James Northcote-Green, Robert Wilson, “Control and automation of electrical power distribution system”, Taylor & Francis Group, LLC,2007.
8. S.Sivanagaraju, V.Sankar, Dhanpat Rai & Co, “Electrical Power Distribution and Automation”,2006.
9. Pansini,Anthony J, “Guide to electrical power distribution system”,Fairmont press, inc., 6th edition,2006.
10. Stuart A. Boyer, “SCADA-Supervisory Control and Data Acquisition” Instrument Society of America Publication,2004
11. Leveque, Francois , “Transport Pricing of Electricity Networks” Springer 2003
12. Lakervi & E J Holmes, “Electricity distribution network design”, Peter Peregrimus Ltd. 2nd Edition,2003
13. William H. Kersting, “Distribution system modeling and analysis” CRC press LLC, 2002.
14. Michael Wiebe, “A Guide to Utility Automation: Amr, Scada, and It Systems for Electric Power” PennWell,1999.
15. IEEE Press: IEEE Recommended practice for Electric Power Distribution for Industrial Plants, published by IEEE, Inc., 1993

EE3041 DC DRIVES

Prerequisite: EE3007 Power Electronics

Total Hrs : 42 Hrs

L	T	P	C
3	0	0	3

Module 1: Introduction **(8 Hrs)**

Introduction to Drives– characteristic matching of the load and the motor - Criteria for selection of subsystems of the Drive - Thermal consideration – considerations in the match between the Power Electronics converter and the motor - Characteristics of mechanical systems - stability criteria

Module 2: Modelling of DC Machine **(8 Hrs)**

Theory of operation – Induced EMF – Equivalent circuit and electromagnetic torque – Elecrtomechanical modeling – state space modeling – Block diagram.

Module 3: Phase controlled DC motor Drives **(14 Hrs)**

Field Control – Armature Control – Four quadrant operation – Single phase controlled convertors - Three phase controlled convertors – half controlled convertor – Converters with freewheeling – Converter configuration for a four quadrant DC motor drive – Steady state analysis of Three phase converter controlled DC motor drive – Two quadrant, Three phase converter controlled DC motor drive. Two quadrant, DC motor drive with field weakening. Harmonics and Associated problems – Effect of field weakening.

Module 4: Chopper Controlled DC motor Drive **(12 Hrs)**

Principle of operation of chopper – Four quadrant chopper circuit and its operation in all quadrants - Model of chopper – Steady state analysis of chopper controlled DC motor drive- Torque pulsations.

Text/Reference Books:

1. Electrical Motor Drives : Modeling, Analysis and control : R Krishnan - 1st edition – 2007 : Pearson Eduction.
2. Electric Drives Concepts and applications – Vedam Subrahmanyam – 1st Edition 1994 : Tata McGrawHill Education Pve Ltd.
3. André Veltman, Duco W.J. Pulle and Rik W. De Doncker : Fundamentals of Electrical Drives – 1st edition 2007 Springer
4. G.K.Dubey & C.R.Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.
5. Dubey ,Power Electronics Drives ,Wiley Eastern,1993
6. Chilikin ,M ,Electric drives , Mir publications, 2nd edition,1976
7. Ned Mohan ,"Power Electronics", et. al ,Wiley 2006

EE3042 ELECTRICAL SYSTEM DESIGN FOR BUILDINGS

Pre-requisites : None

Total Hrs: 42 Hrs

L	T	P	C
3	0	0	3

Module 1: **(10 Hrs)**

Electrical Installations: general requirements, design considerations, testing, estimating and costing - symbols, standards – National Electrical Code – design of panel boards – design and estimation of service connections – design and safety aspects of residential buildings

Module 2: **(10 Hrs)**

Illumination schemes – types of light sources and lighting arrangements – energy efficiency in lamps and illumination – design of lighting for various purposes.

Module 3: **(12 Hrs)**

Electrical system design, estimation and costing of commercial buildings, hospitals, recreational and assembly buildings, cinema theatres, small industries, Design of electrical installations of high rise buildings: electrical aspects of lifts, escalators services, stand by generators.

Module 4: **(10 Hrs)**

Design, estimation and costing of outdoor and indoor Substations –Design of earthing system, earth mat, plate and pipe earthing – Safety of electrical installations – Lightning protection.

Text/Reference Books:

1. K.B. Raina, S.K. Bhatacharya, “Electrical Design, Estimating and Costing,” New Age International (p) Ltd. Publishers, New Delhi, 2002.
2. Surjit Singh. “Electrical Estimating and Costing”, Dhanpat Rai & Co., Delhi, 2005.
3. ISI, National Electrical Code, Bureau of Indian Standard Publications.
4. G. Ramamurthy, “Hand book of Electrical Power Distribution”, Universities Press (India) Private Ltd., New Delhi, 2004.
5. N Alagappan,S Ekambaram, “Electrical estimating and Costing”, Mc Graw Hill,1999

EE3092 ELECTRICAL MACHINES LAB II

Prerequisite: EE3003 Electrical Machines II

L	T	P	C
0	0	3	2

Total Hrs : 42 Hrs

List of Experiments

1. No load and blocked rotor tests on a 3-phase squirrel cage induction motor, determination of its equivalent circuit and performance analysis by drawing the circle diagram.
2. No load and blocked rotor tests on a 3-phase slip ring induction motor, determination of its equivalent circuit and performance analysis by drawing the circle diagram.
3. No load and blocked rotor tests on a single phase induction motor, determination of its equivalent circuit and performance analysis.
4. Load tests on a 3-phase squirrel cage induction motor and its performance analysis.
5. Load tests on a 3-phase slip ring induction motor and its performance analysis.
6. Operation of a dc machine coupled induction machine as an induction generator and its performance analysis.
7. Speed control of an Induction motor by pole changing method.
8. Speed control of an Induction motor by variable frequency method.
9. Predetermination of voltage regulation of a 3-phase alternator by EMF/ MMF methods.
10. Predetermination of voltage regulation of a 3-phase alternator by ZPF method.
11. Slip test on a salient pole alternator and predetermination of voltage regulation.
12. Synchronization of a 3-phase alternator to the supply mains and plotting of V-curves/ inverted V-curves.

Text/Reference Books:

1. Say M. G, Performance & Design of AC Machines, Pitman, ELBS.3rd edition, 1983.
2. Langsdorf A.S., Theory of AC Machinery, McGraw Hill., 2nd edition, 2002.

SEMESTER VII

Sl. No	Code	Title	L	T	P	C	Category
1	MS4003	Economics	3	-	-	3	HL
2	EE4001	Control Systems - II	3	-	-	3	PT
3	EE4090	Electrical Engineering Drawing	1	-	3	3	PT
4		Elective - 5	3	-	-	3	PT
5		Elective - 6	3	-	-	3	FE
6	EE4091	Power Engineering Lab	-	-	3	2	PT
7	EE4092	Project	-	-	3	2	PT
			13	**-**	**9**	**19**	**9**

LIST OF ELECTIVES – VIITH SEMESTER

Sl. No	Code	Title	Credits
1	EE4021	Artificial Neural Networks and Genetic Algorithms	3
2	EE4022	AC Drives	3
3	EE4023	Computer Control of Industrial Processes	3
4	EE4024	Power System Operation and Control	3
5	EE4025	Analog MOS Circuits	3
6	EE4026	Switched-mode Power Supplies	3
7	EE4027	Bio-Signal Processing	3
8	EE4028	Power System Reliability and Deregulation	3
9	EE4029	Control & Guidance Engineering	3
10	EE4030	Switchgear and Protection	3

BRIEF SYLLABI

EE4001 CONTROL SYSTEMS - II

Pre-requisites : None

L	T	P	C
3	0	0	3

Non-linear Systems - Characteristics- types of nonlinearities Phase plane analysis Lyapunov's First method- Isocline and Delta method- limit cycles of phase plane- Concepts of Inverse Control-Feedback linearization- Principles of model predictive control. Describing functions- single valued and double valued non-linear elements - Limit cycles amplitude and frequency -Stability of non-linear systems . Lyapunov.s method for non-linear systems . Popov.s criterion- Circle criterion .Controllability Observability -State variable design, design of full order and reduced order observers. : Optimal control problem –State feedback regulator problem- Computer Control of Industrial Processes--Microprocessor/microcontroller/DSP based control-Programmable Logic controllers- PLC Programming-PC based control-Distributed Control Systems-

Total Hours: 42 Hours

EE4021: ARTIFICIAL NEURAL NETWORKS & GENETIC ALGORITHM METHODS

Prerequisite: NIL

L	T	P	C
3	0	0	3

Introduction to Artificial Neural Networks - Introduction to network architectures - knowledge representation - Learning process .Learning algorithms- Neural Network Architectures-MLFFN-Recurrent NN- RBF Network structure - separability of patterns - RBF learning strategies - comparison of RBF, RNN and MLP networks- Hopfield networks- Genetic Algorithm- Application to Engineering problems -Concept of neuro-fuzzy and neuro-genetic systems- GA as an optimization tool for ANN-Application of ANN in forecasting-Signal characterization-Fault diagnosis-Neuro-Fuzzy-Genetic Systems- Case Studies in solving Engineering problems of control, signal/image processing etc.

Total Hours: 42 Hours

EE4022 AC DRIVES

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

AC machines for Drives - Principle of operation, Equivalent circuit, Modeling and characteristics of machines for drives. Phase controlled Induction motor Drives - Phase Controlled Cycloconverters – Stator Voltage control – Slip energy recovery scheme - Frequency controlled Induction motor Drives - Voltage Source Inverter (VSI) – VSI fed Induction motor - constant V/F control – Constant Flux control – Constant Slip-speed control – Flux weakening operation - Current Source Inverter (CSI) fed Induction motor Drives - Vector controlled Induction motor Drives – Permanent Magnet Motor drives.

Total Hours : 42 Hours

EE4023 COMPUTER CONTROL OF INDUSTRIAL PROCESSES

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Multivariable Control - H^2 / H Theory- Solution for design using H^2 / H - Case studies - Programmable Logic Controllers - Large Scale Control System – SCADA - Real Time Systems

Total Hrs: 42 Hrs

EE4024 POWER SYSTEM OPERATION AND CONTROL

Pre-requisites : None

L	T	P	C
3	0	0	3

Economic dispatch of thermal units and methods of solution- Unit commitment- Scheduling problems- AGC-Single and multi area system- AVR- Interchange of power and energy- Economy interchange between interconnected utilities- Power system security.

Total Hours: 42 Hours

EE4025 ANALOG MOS CIRCUITS

Pre-requisites: EE 2004 Basic Electronic Circuits
EE 2008 Analog Electronic Circuits

L	T	P	C
3	0	0	3

Basic MOS Device Physics and models -Single-Stage Amplifiers- Current sources and sinks –Passive and Active current mirrors - Differential amplifiers – CMOS Operational amplifiers – Mixed signal circuits – CMOS comparator design – analog multiplier – dynamic analog circuits – Introduction to switched capacitor circuits-MOSFET as switch – sample and hold circuits– switched capacitor filters -Ring Oscillator, LC oscillator, VCO - PLL, Charge pump PLL, delay locked loops and applications.

Total Hours: 42 Hours

EE4026 SWITCHED MODE POWER SUPPLIES

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Introduction - Topologies of SMPS – EMI issues - Magnetic Circuits and design – Transformer design - - Inductor design - Power semiconductor selection and its drive circuit design – snubber circuits. Closing the feedback loop – Voltage Mode Control of SMPS - Current Mode Control and its advantages - Current Mode Vs Voltage Mode - Applications of SMPS - Resonant converters

Total Hours: 42 Hours

EE4027 BIO SIGNAL PROCESSING

Pre-requisites : None

L	T	P	C
3	0	0	3

Discrete time signals and systems –classification and representation of discrete –time signals - Classifications of sequences –basic operation of sequences – discrete time systems – Discrete Time Fourier Transform - Discrete Fourier Transform- Z- transform - The brain and it's potentials – electrophysiological origin of brain waves – EEG signal and it's characteristics – EEG analysis – linear prediction theory – recursive estimation of AR parameters –ECG signal processing –ECG data compression techniques- clinical applications-

Total Hours: 42 Hours

EE4028 POWER SYSTEM RELIABILITY AND DEREGULATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Generator System Models, Reliability Indices, Interconnected Systems, Operating Reserve, Economics & Reliability, Distribution System - Parallel And Mesh Networks, Industrial Systems. Deregulated Systems- Introduction of Market structure-Market Architecture, Marginal cost of generation, Least-cost operation, Incremental cost of generation. Reconfiguring Power systems, Transmission network and market power, Power wheeling transactions and marginal costing, Transmission costing.

Total Hours : 42 Hours

EE4029 CONTROL & GUIDANCE ENGINEERING

Pre-requisites : EE3002 Control Systems I

L	T	P	C
3	0	0	3

Navigation Systems - Basics of satellite based navigation systems: Global Positioning Systems (GPS) and Global Navigation of Satellite Systems (GNSS) - Guidance Systems: Gyros: Principle of operation- Accelerometers- Navigation equations-Schuler principle and mechanization - Space vehicle dynamics and control - Missile guidance and Control –

Total Hours: 42 Hours

EE4030 SWITCHGEAR AND PROTECTION

Pre-requisites : None

L	T	P	C
3	0	0	3

Circuit breakers – principle of operation – classification –surges and traveling waves – protection against lightning – neutral earthing- basic concepts of insulation levels and their selection – protective relays – characteristics and types – protection schemes for equipments – standards and specifications related to switch gear and protection.

Total Hours: 42 Hours

EE4090 ELECTRICAL ENGINEERING DRAWING

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
1	0	3	3

Dc simplex lap/ wave armature windings - ac single layer/ double layer armature windings - sectional views of transformer limb with windings, core assembly of a power transformer and transformer tank with its accessories/ bushings - sectional views of dc machine armature with commutator and assembled dc machine - sectional views of salient pole and turbo alternators - sectional views of slip ring and squirrel cage induction motors - layouts and single line diagrams of substations.

Total Hours: 56 Hours

EE4091 POWER ENGINEERING LAB

Pre-requisite: EE3004 Power Systems I & EE3007 Power Electronics

L	T	P	C
0	0	3	2

14 Experiments on various power system relays, characteristics of power semiconductor devices, characteristics of Solar PV Modules, Converters and Inverters

Total Hours : 42 Hours

DETAILED SYLLABI

EE4001 CONTROL SYSTEMS - II

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Non-linear Systems - Characteristics- different types of nonlinearities and their occurrences Phase plane analysis . linearization and equilibrium points - stability of equilibrium points-Lyapunov's First method- Isocline and Delta method- limit cycles of phase plane- stability of limit cycles . Bendixson's criteria-Computer based analysis and simulation. Concepts of Inverse Control-Feedback linearization-Principles of model predictive control

Module 2: **(10 Hrs)**

Describing functions- Filter hypothesis- describing function for single valued and double valued non-linear elements - Limit cycles amplitude and frequency -Stability of non-linear systems . Lyapunov.s method for non-linear systems . Popov.s criterion- Circle criterion

Module 3: **(11 Hrs)**

Controllability Observability -state variable design, state feedback, pole placement - Ackerman's formula – design of full order and reduced order observers. : Optimal control problem – different performance measures and constraints - Optimal control using quadratic performance measures -State feedback regulator problem-

Module 4: **(10 Hrs)**

Compute Computer Control of Industrial Processes-Control hierarchies for plant level automation-Microprocessor/microcontroller/DSP based control-Programmable Logic controllers- Introduction to PLC Programming-PC based control-Distributed Control Systems-Control Networks-Protocols-Ethernet-Field Bus-Man-Machine Interface.

Text/Reference Books:

1. Benjamin C Kuo, *Digital Control Systems*, Oxford University Press, 1992
2. Hassan K Khalil, *Nonlinear Systems*., Prentice Hall International (UK),1996
3. Mohandas K P : Modern Control Engineering,(Revised edition) Sanguine Pearson 2010
4. Alberto Isidori, .*Nonlinear Control Systems*., Springer Verlag, 1995.
5. S. Wiggins, .*Introduction to Applied Nonlinear Dynamical Systems and Chaos*, Springer Verlag, 1990
6. M. Gopal, *Digital Control & State Variable Methods*, Tata McGrawHill, 1992.

EE4021: ARTIFICIAL NEURAL NETWORKS & GENETIC ALGORITHM METHODS

Prerequisite: NIL

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Introduction to Artificial Neural Networks - Biological neurons .Computational models of neuron- McCulloch - Pitts model - types of activation function .Introduction to network architectures - knowledge representation - Learning process .Learning algorithms- - error-correction learning .Boltzmann learning-Hebbian learning, competitive learning- Learning paradigms- supervised learning - unsupervised learning - method of steepest descent - least mean square algorithms - Adaline/medaline units . perceptrons- derivation of the back-propagation algorithm-Adavnces in Learning strategies-Computer based simulation of simple Network Structures.

Module 2: **(11 Hrs)**

Neural Network Architectures-MLFFN-Recurrent NN- RBF Network structure - separability of patterns - RBF learning strategies - comparison of RBF, RNN and MLP networks- Hopfield networks- associative memory-energy function - spurious states - error performance - simulated annealing - applications of neural networks . Forecasting-the XOR problem - traveling salesman problem - image compression using MLPs - character retrieval using Hopfield networks-Advances in ANN Theory- Computer based simulation.

Module 3: **(11 Hrs)**

Genetic Algorithm-Introduction to Genetic Algorithms . The GA computation process-natural evolution-parent selection-crossover-mutation-properties - classification – Advances in the theory GA- Application to Engineering problems

Module 4: **(9 Hrs)**

Hybrid systems and Soft Computing- Limitations of ANN and GA- Concept of neuro-fuzzy and neuro-genetic systems- GA as an optimization tool for ANN-Application of ANN in forecasting-Signal characterization-Fault diagnosis-Neuro-Fuzzy-Genetic Systems- Case Studies in solving Engineering problems of control, signal/image processing etc.

Text/Reference Books:

1. Simon Haykin, *Neural Network – A Comprehensive Foundation*, 2nd Ed, Pearson Education, 2002.
2. Zurada J.M., *Introduction to Artificial Neural Systems*, Jaico Publishers,2003.
3. Bart Kosko, *Neural Network and Fuzzy Systems*, Prentice Hall of India, 2002
4. Goldberg D.E., *.Genetic Algorithms in Search Optimization and Machine Learning*, Addison Wesley,1989
5. Suran Goonatilake & Sukhdev Khebbal (Eds.), *Intelligent Hybrid Systems*., John Wiley,1995.
6. Hassoun Mohammed H, *Fundamentals of Artificial Neural Networks*, Prentice Hall of India, 2002.

EE4022 AC DRIVES

Prerequisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: AC Machines for Drives (8 Hrs)

Induction machine – Synchronous machine – Permanent Magnet machines – Synchronous reluctance and variable reluctance machine – Principle of operation, Equivalent circuit, Modeling and characteristics of all these machines.

Module 2: Phase Controlled Induction Motor Drives (13 Hrs)

Cycloconverters - Phase Controlled Cycloconverters – Circuits and operation principle – Circulating and non-circulating current mode – load and line harmonics – Line Displacement power factor. Stator Voltage control – Slip energy recovery scheme.

Module 3: Frequency Controlled Induction Motor Drives (10 Hrs)

Voltage Source Inverter (VSI) – VSI fed Induction motor - constant V/F control – Constant Flux control – Constant Slip-speed control – Torque pulsation – effect of Harmonics and its control - PWM control – Flux weakening operation.

Module 4: Current Source Inverter fed Induction Motor Drives (11 Hrs)

Current Source Inverter (CSI) fed Induction motor Drives - CSI – Operation – Modeling - Steady state performance of CSI motor drive. Vector controlled Induction motor Drives – principle and operation. Permanent Magnet Motor drives.

Text/Reference Books:

1. Electrical Motor Drives : modeling, Analysis and control : R Krishnan - 1st edition – 2007 : Pearson Eduction.
2. Electric Drives Concepts and applications – Vedam Subrahmanyam – 1st Edition 1994 : Tata McGrawHill Education Pve Ltd.
3. André Veltman, Duco W.J. Pulle and Rik W. De Doncker : Fundamentals of Electrical Drives – 1st edition 2007 Springer
4. G.K.Dubey & C.R.Kasaravada ,"Power Electronics & Drives", Tata McGraw Hill,1993.
5. Dubey ,Power Electronics Drives ,Wiley Eastern,1993
6. Chilikin ,M ,Electric drives , Mir publications, 2nd edition,1976
7. Ned Mohan ,"Power Electronics", et. al ,Wiley 2006

EE4023 COMPUTER CONTROL OF INDUSTRIAL PROCESSES

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total Hrs: 42 Hrs

Module 1: Multivariable Control **(12 Hrs)**

Multivariable control- Basic expressions for MIMO systems- Singular values- Stability norms- Calculation of system norms- Robustness- Robust stability- H^2 / H Theory- Solution for design using H^2 / H - Case studies. Interaction and decoupling- Relative gain analysis- Effects of interaction- Response to disturbances- Decoupling- Introduction to batch process control.

Module 2: Programmable Logic Controllers **(10 Hrs)**

Programmable logic controllers- Organisation- Hardware details- I/O- Power supply- CPU- Standards- Programming aspects- Ladder programming- Sequential function charts- Man- machine interface- Detailed study of one model- Case studies.

Module 3: Large Scale Control System **(12 Hrs)**

SCADA: Introduction, SCADA Architecture, Different Commnication Protocols, Common System Components, Supervision and Control, HMI, RTU and Supervisory Stations, Trends in SCADA, Security Issues

DCS: Introduction, DCS Architecture, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.

Module 4: Real Time Systems **(8 Hrs)**

Real time systems- Real time specifications and design techniques- Real time kernels- Inter task communication and synchronization- Real time memory management- Supervisory control- direct digital control- Distributed control- PC based automation.

Text/Reference Books:

1. Shinskey F.G., Process control systems: application , Design and Tuning, McGraw Hill International Edition , Singapore,1988.

2. Be.langer P.R. , Control Engineering: A Modern Approach, Saunders College Publishing , USA, 1995.

3. Dorf, R.C. and Bishop R. T. , Modern Control Systems , Addison Wesley Longman Inc., 1999

4. Laplante P.A., Real Time Systems: An Engineer.s Handbook, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.

5. Constantin H. Houpis and Gary B. Lamont, Digital Control systems, McGraw Hill Book Company, Singapore, 1985.

6. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications,USA,1999

7. Gordon Clarke, Deon Reynders:Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004

8. Efim Rosenwasser, Bernhard P. Lampe, Multivariable computer-controlled systems: a transfer function approach, Springer, 2006

EE4024 POWER SYSTEM OPERATION AND CONTROL

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Economic dispatch of thermal units and methods of solution- Formulation of AC power flow- Transmission losses- B matrix loss formula- Take-or-pay fuel supply contract- Composite generation production cost function- solution by gradient search techniques.

Module 2: **(11 Hrs)**

Unit commitment- Solution methods- Hydrothermal coordination- Scheduling problems- Short term hydrothermal scheduling problem - Short term hydro scheduling-load model - prime mover model - governor model - tie-line model - generation control.

Module 3: **(10 Hrs)**

AGC-Single and multi area system-Speed governing -TG response-ALFC loop-tie line bias control - AVR-Exciter types-Modeling - AVR loop

Module 4: **(10 Hrs)**

Interchange of power and energy- Economy interchange between interconnected utilities- inter - utility economy energy evaluation- capacity interchange - diversity interchange - energy banking- emergency power interchange - power pools.

Power system security -factors affecting power system security - contingency analysis- linear sensitivity factors - optional power flow - linear sensitivity analysis -state estimation

Text/Reference Books:

1. A.J. Wood and B.F. Wollenberg, “Power Generation Operation and Control”, John Wiley & Sons, ICN., 2nd Edition.
2. A.K.Mahalanabis, “Computer Aided Power system analysis and control”, Tata McGraw Hill 1991
3. O.I. Elgerd: “Electric Energy Systems Theory”, McGraw Hill, 2nd Edition, 1982,Dec.
4. Antonio Gomez-Exposito, Antonio j.conejo & Claudio canizares, “Electric Energy systems analysis and operation”, CRP press, 2009.

EE4025 ANALOG MOS CIRCUITS

Pre-requisites: EE 2004 Basic Electronic Circuits
EE 2008 Analog Electronic Circuits

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Basic MOS Device:

Analog MOS models – Device construction, Principle of operation, static characteristics, Body effect on static characteristics and DC biasing, VVR explanation and use, channel length modulation – Early Voltage, low frequency model – MOS in saturation –high frequency model – MOS resistors and resistor circuits

Module 2: **(9 Hrs)**

Single-Stage Amplifiers-– common source –common gate – common drain amplifiers, cascode and folded cascode structures

Current sources and sinks – regulated cascode current source/sink, Wilder current source

Passive and Active current mirrors – Basic Current mirrors-cascode current mirror – Wilson current mirror – Active Current mirror

Module 3: **(11 Hrs)**

Differential amplifiers – Basic differential pair, common mode response.

Frequency response of amplifiers- General considerations of Miller effect, common source, common gate, common drain amplifiers, cascade and differential pair.

CMOS Operational amplifiers – Basic one and two stage CMOS OAs, folded cascade type.

Module 4: **(12 Hrs)**

Mixed signal circuits – CMOS comparator design – analog multiplier – dynamic analog circuits – charge injection and capacitive feed through in

Introduction to switched capacitor circuits- MOSFET as switch – sample and hold circuits– switched capacitor filters

Ring Oscillator, LC oscillator, VCO - PLL, Charge pump PLL, delay locked loops and applications.

Text/Reference Books:

1. Adel S. Sedra and K. C. Smith, 'Microelectronic circuits' 4th edition, Oxford University Press, 2003
2. Jacob Baker R., Li H.W.& Boyce D.E., `CMOS - Circuit Design, Layout & Simulation', PHI,2005.
3. Behzad Razavi, 'Design of Analog CMOS Integrated Circuit' Tata-Mc GrawHill, 2002.
4. Roubik Gregorian & Gabor C Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley, 1986.

EE4026 SWITCHED MODE POWER SUPPLIES

Prerequisite: EE3007 Power Electronics

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

Module 1: Introduction **(8 Hrs)**

Linear regulator Vs. Switching regulator – Topologies of SMPS – isolated and non isolated topologies – Buck – Boost – Buck boost – Cuk – Polarity inverting topologies – Push pull and forward converters half bridge and full bridge – Fly back converters Voltage fed and current fed topologies. EMI issues.

Module 2: Design Concepts **(10 Hrs)**

Magnetic Circuits and design – Transformer design - core selection – winding wire selection – temperature rise calculations - Inductor design. Core loss – copper loss – skin effect - proximity effect. Power semiconductor selection and its drive circuit design – snubber circuits. Closing the feedback loop – Control design – stability considerations

Module 3: Control Modes **(12 Hrs)**

Voltage Mode Control of SMPS.. Transfer Function and Frequency response of Error Amp. Transconductance Error Amps . PWM Control ICs (SG 3525,TL 494,MC34060 etc.)

Current Mode Control and its advantages. Current Mode Vs Voltage Mode. Current Mode PWM Control IC(eg. UC3842).

Module 4: **(12 Hrs)**

Applications of SMPS - Active front end – power factor correction – High frequency power source for fluorescent lamps - power supplies for portable electronic gadgets.

Resonant converters

Principle of operation – modes of operation – quasi resonant operation- advantages.

Text/Reference Books:

1. Abraham I Pressman - Switching power supply design – 2nd edition 1998 Mc-Graw hill Publishing Company.
2. Keith H Billings - Switch mode power supply handbook – 1st edition 1989 Mc-Graw hill Publishing Company.
3. Sanjaya Maniktala - Switching power supplies A to Z. – 1st edition 2006, Elsevier Inc.
4. Daniel M Mitchell : DC-DC Switching Regulator Analysis. McGraw Hill Publishing Company
5. Ned Mohan et.al : Power Electronics. John Wiley and Sons.
6. Otmar Kilgenstein : Switched Mode Power Supplies in Practice. John Wiley and Sons.
7. Mark J Nave : Power Line Filter Design for Switched-Mode Power Supplies. Van Nostrand Reinhold, New York.

EE4027 BIO SIGNAL PROCESSING

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(12 Hrs)**

Discrete time signals and systems –classification and representation of discrete –time signals
Classifications of sequences –basic operation of sequences – discrete time systems – Discrete Time Fourier Transform - Discrete Fourier Transform – computation of DFT –Mathematical derivation of unilateral z-Transform – properties of z- Transform –the inverse z – Transform – bilateral z –Transform -power series – region of convergence

Module 2: **(12 Hrs)**

The brain and it's potentials – electrophysiological origin of brain waves –EEG signal and it's characteristics – EEG analysis – linear prediction theory – recursive estimation of AR parameters
Spectral error measure – transient detection and elimination (the case of epileptic patents)-review of Wiener Filtering Problem – principle of adaptive filter –the Steepest -Descent Algorithm -50Hz interference and it's cancellation –cancellation of ECG signal from the electrical activity of the chest muscles -

Module 3: **(10 Hrs)**

Basic electrocardiography- ECG data a acquisition-ECG lead systems – steps in ECG analysis -ECG parameters and their estimation – QRS detection algorithm -arrhythmia analysis and monitoring - long term ECG recording

Module 4: **(8 Hrs)**

Direct ECG data compression techniques – Transformation compression Techniques –other data compression techniques – Prony's method – clinical applications

Text/Reference Books:

1. Biomedical signal processing by DC Reddy , TMH 2005 edition
2. A Biomedical signal processing by Willis J Tompkins, PHI, 2009
3. Biomedical signal analysis by Rangaraj M. Rangayyan ,IEEE Press, 2002
4. Bioelectrical signal processing in cardiac and neurological applications : Leif Sornmo and Pablo
5. Laguna , Elsevier Academic Press, 2005
6. Advances in Cardiac Signal Processing , U.R. Acharya J.S. Suri JAE Spaan, S.M.Krishnan(Editotrs)

EE4028 POWER SYSTEM RELIABILITY AND DEREGULATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: **(10 Hrs)**

Generator System Models- State Load Model- Probability Methods- Unit Unavailability- Outage Probability- Generating Capacity Limits- Recursive Techniques- Capacity Expansion Analysis - Scheduled Outages - Reliability Indices- Frequency Duration Method. Power quality issues.

Module 2: **(11 Hrs)**

Interconnected Systems - Two Systems with Tie- Probability Array Methods- Reliability Indices- Variable Reserve And Maximum Peak Load Reserve- Multi Connected Systems.

Distribution System- Interruption Indices- System Performance- risk prediction- Radial Systems- Effect Of Load Transfer- Line Failures- Parallel And Mesh Networks- Industrial Systems.

Module 3: **(10 Hrs)**

Deregulated Systems: Need and conditions for deregulation-Introduction of Market structure-Market Architecture-Spot market-forward markets and settlements. Review of Concepts- marginal cost of generation-least-cost operation-incremental cost of generation.

Module 4: **(11 Hrs)**

Reconfiguring Power systems- Unbundling of Electric Utilities- Competition and Direct access. Transmission network and market power - Power wheeling transactions and marginal costing - transmission costing. Framework and methods for the analysis of Bilateral and pool markets.

Text/Reference Books:

1. Dong, Z., Zhang, P. Ma, J., Zhao, J., Ali, Meng, K., Yin, "Emerging Techniques in Power System Analysis" Springer, 1st edition 2010.
2. S.C. Savulescu, "Real-Time Stability assessment in modern power system control centres", John Wiley & Sons, January 2009
3. Eric Monmasson, "Static Converters", John Wiley & Sons, September 2009.
4. Bo Bergman, Jacques de Mare, Thomas Svensson, Sara Loren, "Robust Design methodology for reliability", John Wiley & Sons, October 2009
5. Ali A. Chowdhury, Don O. Koval, "Power distribution system reliability-Practical methods and applications" John Wiley & sons Inc., *IEEE Press* 2009
6. Richard E.Brown, "Elactric power distribution reliability" Taylor & Francis Group,LLC,2009.
7. Elmakias, David (Ed.) "New Computational Methods in Power System Reliability" Studies in Computational Intelligence, Springer 2008
8. Leveque, Francois , "Transport Pricing of Electricity Networks" Springer 2003
9. Steven Stoft , " Power System Economics-Designing markets for electricity" *IEEE Pres*,2002
10. M. Shahidehpour, H. Yamin and Zuyi Li, "Market operations in electric power systems-Forecasting, scheduling and risk management" John Wiley & sons Inc., 2002
11. Kankar Bhattacharya, Math H.J. Bollen, and Jaap E. Daalder, "Operation of restructured power systems", Kluwer international series,2001
12. Loe lei lai, "Power system restructuring and deregulation- trading, performance and information technology", John Wiley and sons,ltd,2001
13. Wilson K. Kazibwe and Musoke H Semdaula. "Electric Power Quality Control Techniques". Van Nostarand Reinhold New York.2001
14. Yong-Hua Song "Modern Optimisation Techniques in Power Systems" Intelligent Systems, Control and Automation: Science and Engineering, Vol. 20, Springer 1999
15. Roy Billinton, Ronald N. Allan, "Reliability Assessment of Large Electric Power Systems", *IEEE Press* 1995
16. R.Ramakumar, "Reliability Engineering: Fundamentals and Applications", Prentice Hall, 1993
17. Roy Billinton, "Power System Reliability Evaluation", Plenum Press, New York,1991
18. 7.J. Endrenyi, "Reliability Modeling in Electrical Power Systems", *Wiley* New York, 1978

EE4029 CONTROL & GUIDANCE ENGINEERING

Pre-requisites : EE3002 Control Systems I

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(12 Hrs)**

Navigation Systems:

General principles of early conventional navigation systems-Geometric Concepts of navigation-Reference frames-Direction cosine matrix-Euler angles-Transformation of angular velocities-Quaternion representation in co-ordinate transformations-Comparison of transformation methods. Inertial platforms-Stabilized platforms-Gimbaled and Strap down INS and their mechanization-Gyrpcompassing for initial alignment, Externally aided inertial navigation systems, TACAN, TERCOM, LORAN, OMEGA, DECCA, VOR, DME, JTIDS, FLIR-Basics of satellite based navigation systems: Global Positioning Systems (GPS) and Global Navigation of Satellite Systems (GNSS)

Module 2: **(10 Hrs)**

Guidance Systems:

Guidance information requirements-Energy Conservation Methods-Time Conservation Methods-Collision Warning and Avoidance-Rendezvous - Satellite Orbit maintenance-Inertial navigation-block diagram representation of essential components-Inertial sensors, Gyros: Principle of operation-TDF and SDF gyros-precession-Nutation-gimbal lock-gimbal flip-gyro transfer function-rate gyro-integrating gyro-Constructional details and operation of floated rate integrating gyro-Dynamically tuned gyro-Ring laser gyro-Fiber optic gyro-gyro performance parameters-Accelerometers-transfer function-Pendulous gyro integrating accelerometer-Vibrating String accelerometer-Accelerometer performance parameters- Navigation equations-Schuler principle and mechanization

Module 3: **(10 Hrs)**

Space vehicle dynamics and control:

Powered flight-unpowered flight-Orbital mechanics, Orbital parameters, circular, elliptical, parabolic, hyperbolic and rectilinear orbits, energy of the orbit, orbital transfer and rendezvous, LEO, SSPO,GSO,GTO orbits, impulse transfer between circular orbits, Hoffmann transfer, other co-planar and non-coplanar transfers, N-body problem, two-body problem- Re-entry of space vehicle, re-entry dynamics, ballistic re-entry, skip re-entry, double-dip re-entry, aerobraking, lifting body re-entry, entry corridor, equilibrium glide, thermal and structural constraints, commanded drag guidance.

Module 4: **(10 Hrs)**

Missile guidance and Control:

Guided missile - surface to surface, surface to air, air to surface and air to air missiles. Tactical and strategic missile, Subsystems of a missile – airframe, flight control and guidance, warhead, data link, fuze, propulsion, telemetry. Control – Canad, wing and tail control. Steering policy – skid to turn (STT), preferred orientation control (POC), bank to turn (BTT) and hybrid. Aerodynamic and Ballistic missiles. Auto pilots. Types of fuze, warhead and propulsion systems. Guidance sequence, different schemes of guidance during launch, midcourse and terminal phases. Collision avoidance

Text/Reference Books:

1. Marshall H Kaplan, Modern Spacecrafts dynamics and control' John Wiley & Sons, 1976.
2. Hanspeter Schaub, John L. Junkins, Analytical Mechanics of Space Systems, AIAA, USA, 2003.
3. Edward V B Stearns, Navigation and Guidance in Space, Prentice Hall, 1983.
4. Manuel Fernadez, George R Macomber, Inertial Guidance Engineering, Prentice Hall, 1962.
5. Ching-Fang –Lin, Modern Navigation, Guidance, and Control Processing, Prentice-Hall, 1991.
6. M.J. Zucrow, Aircraft & Missile Propulsion**,** John Wiley & Sons, 1958.
7. David B. Newman, Space Vehicle Electronics, D. Van Nostrand Co, 1964.
8. A C Kermode, Mechanics of flight, Pearson Education, 2004
9. Paul Zarchan, Tactical and Strategic Missile Guidance, AIAA, 2007.

EE4030 SWITCHGEAR AND PROTECTION

Pre-requisites : None

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

Module 1: **(10 Hrs)**

Circuit breakers-principles of operation–RRRV-Current chopping. Constructional features and Selection of LT breakers (MCB/MCCB/ELCB) and HT Breakers (ABCB - OCB – SF_6CB– VCB); Circuit breaker ratings-Testing of circuit breakers.

Module 2: **(10 Hrs)**

Overvoltages – Surges and travelling waves – Wave propagation on transmission lines - reflection and attenuation- Lightning strokes- protection against lightning - earth wires- lightning diverters - surge absorbers - arcing ground - neutral earthing - basic concepts of insulation levels and their selection - BIL – Co-ordination of insulation.

Module 3: **(12hours)**

Protective relays - protective zones - requirement of protective relaying- definitions-Codes-Standards - Types – Over current Relays - Earth fault relays- Directional relays- Differential relays- Distance relays- Under voltage/ Frequency relays. Static, digital and numerical relays-PC based relays-Construction-Characteristic Functions-Converter Elements-Comparators-Relay Schematics, Analysis.

Module 4: **(10 Hrs)**

Protection Scheme for Generators-Power Station & DG sets, Power & Distribution Transformers, Transmission lines and Busbars, Motors.

NEC and importance of relevant IS/IEC specifications related to switchgear and protection.

Text/Reference Books:

1. Sunil S Rao, “Switch Gear Protections”, Khanna Publications, Delhi 1999
2. Allen Greenwood, “ Electrical Transients in Power Systems”, 1991.
3. Van. C. Warrington A.R., “Protective Relays” Vol. 1 & 2, Chapman & Hall, 1998.
4. T S Madhav Rao, “Power system protection static relays with microprocessor Applications”, Tata McGraw hill Publication,1998.
5. Badri Ram, D N Vishwakarma, “ Power System Protection and Switchgear’, Tata Mc Graw Hill, 2005.
6. Anderson P M, “ Power System Protection”, IEEE publication, 1999.
7. Walter -Marcel Dekker, “Protective relaying theory and applications”, 2ed, Elmore, 2004.

EE4090 ELECTRICAL ENGINEERING DRAWING

Pre-requisites: EE2007 Electrical Machines I & EE3003 Electrical Machines II

L	T	P	C
1	0	3	3

Total Hours: 56 Hours

Module 1: Armature Windings **(16 Hrs)**

1. Simplex lap/ wave dc armature windings with equalizer rings/ dummy coils.
2. Simplex lap/ wave, integral/ fractional slot, double layer three phase ac armature windings with full pitched/ short chorded coils.
3. Mush type/ concentric, 2-tier/ 3-tier, bifurcated/ unbifurcated single layer three phase ac armature windings.

Module 2: Transformers **(12 Hrs)**

1. Sectional plan and elevation of a transformer limb with windings.
2. Sectional plan and elevation of the core assembly of a power transformer.
3. Sectional plan and elevation of a distribution transformer tank with its accessories.
4. Sketches of capacitor and oil filled type transformer bushings.

Module 3: Rotating Machines **(24 Hrs)**

DC Machines

1. Sectional front and side elevation of armature with commutator.
2. Sectional front and side elevation of yoke and pole assembly with field winding.
3. Sectional front and side elevation of assembled Machine.

Alternators

1. Sketches of the methods of pole fixing and slot details of turbo & water wheel alternators.
2. Sectional front and side elevation of water wheel rotor assembly with winding.
3. Sectional front and side elevation of salient pole alternator.
4. Sectional front and side elevation of turbo alternator.

Induction Motors

1. Sectional front and side elevation of slip ring induction motor.
2. Sectional front and side elevation of squirrel cage induction motor.

Module 4: Substations **(4 Hrs)**

1. Layouts and single line diagrams of outdoor and indoor substations.
2. Layout of a 220KV substation.
3. Layout of a captive power substation.
4. Single line diagram of a distribution center.

Text/Reference Books:

1. Clayton & Hancock, Performance and Design of DC Machines, ELBS, 1992.
2. Say M.G, Performance and Design of AC machines, Pitman, ELBS, 1991.
3. A.K. Sawhney, Electrical Machine Design, Dhanpath Rai, New Delhi, 1991.
4. Narang K.L., A Text Book of Electrical Engineering Drawing, Tech India Publications.
5. Bhattacharya S.K, Electrical Engineering Drawing, Wiley Eastern, Edition 2.

EE4091 POWER ENGINEERING LAB

Pre-requisite: EE3004 Power Systems I & EE3007 Power Electronics

L	T	P	C
0	0	3	2

Total Hours : 42 Hours

List of Experiments

1. IDMT Over current relay: plot the IDMT characteristics of the inverse over current relay, identify PSM and settings required for a 3 phase 5 hp induction motor with 120% overload limit, Determine the tripping time for 50*I.
2. Under voltage and Over voltage relay: Plot the inverse characteristics of the relay in under and over voltage operation zone. Determine the tripping time for 150*V and 50*V.
3. Design and setup a single-phase full-converter and study its performance for R and RL loads.
4. Solar PV Module: Plot I-V characteristics of a P-V Module. Determine the maximum power point and power transferred for a lamp load.
5. Design and setup a single-phase semi-converter and study its performance for R and RL loads.
6. Design and set up a Single Phase half wave rectifier and study its performance for R and RL loads.
7. Design and set up a Single Phase AC voltage controller using Triac.
8. Design and set up a Single Phase square wave inverter and study the effect of variation is DC Bus voltage and duty cycle.
9. Study of V-I characteristics of Thyristor.
10. Study of V-I characteristics of IGBT.
11. Study of V-I characteristics MOSFET.
12. Study of switching characteristics of IGBT.
13. Study of switching characteristics of MOSFET.
14. Cable Testing: Determine the IR value, conductor resistance and calculate the leakage current. Conduct HV test on 415V grade cable.

Text/Reference Books:

1. Ned Mohan et.al ,"Power Electronics",John Wiley and Sons,2006
2. Rashid, Power Electronics, Circuits Devices and Applications, Pearson Education, 3rd edition, 2004.
3. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
4. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.
5. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

SEMESTER VIII

Sl. No	Code	Title	L	T	P	C	Category
1	ME4104	Principles of Management	3	-	-	3	PT
2	EE4002	Instrumentation Systems	3	-	-	3	PT
3		Elective - 7	3	-	-	3	PT
4		Elective - 8	3	-	-	3	FE
5	EE4093	Seminar	-	-	2	1	PT
6	EE4094	Control Systems Lab	-	-	3	2	PT
7	EE4095	Project	-	-	6	4	PT
			12	**-**	**11**	**19**	

LIST OF ELECTIVES – VIIITH SEMESTER

Sl. No	Code	Title	Credits
1	EE4031	Advanced Digital Signal Processing	3
2	EE4032	Static VAr Compensation and Harmonic Filtering	3
3	EE4033	Optimal and Adaptive Control	3
4	EE4034	Power System Stability and Control	3
5	EE4035	Flexible AC Transmission	3
6	EE4036	Non-linear System Analysis	3
7	EE4037	Energy Auditing, Conservation and Management	3
8	EE4038	Data Acquisition and Signal Conditioning	3
9	EE4039	Advanced DC – AC Power Conversion	3
10	EE4040	System Identification and Parameter Estimation	3
11	EE4041	Power Quality	3
12	EE4042	Digital Protective Relaying	3

BRIEF SYLLABI

ME4104 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil

Introduction to management theory, Characteristics, Systems approach, Task responsibilities and skill required, Process of management, Planning, Organizing, Directing, Controlling, Decision making process, Project management, Overview of operations management, Human resources management, Marketing management, Financial management.

Total Hours: 42 hours

EE4002: INSTRUMENTATION SYSTEMS

Prerequisites: EE2001 Signals and Systems,
EE2008 Analog Electronic Circuit and systems

L	T	P	C
3	0	0	3

Measurement, Instrumentation and Calibration– Errors in measurement - Calibration and Standards - Signals and their representation. - Electrical Measuring systems – Dynamics of Instrument systems – generalized performance of systems – electrical Networks – Mechanical systems - Electromechanical systems –Thermal systems – Fluidic systems – Filtering and Dynamic Compensation - Basics of Temperature, pressure, Force, Torque, Density, Liquid level, Viscosity, Flow, Displacement, measurement. Passive Electrical Transducers – Digital Transducer, Feed back Transducers Systems –Signal processing Circuits –

Total Hours: 42 Hours

EE4031 ADVANCED DIGITAL SIGNAL PROCESSING

Pre-requisite: **EE3005 Digital Signal Processing**

L	T	P	C
3	0	0	3

Optimization Methods for IIR and FIR filter Design both in frequency and time domain –Algorithms for design and algorithms for implementation; Speech signal processing- Speech production models – Analysis of speech signals - Different coding methods; Two dimensional signal processing (Image Processing)- Digital image representation- Image enhancement- color image processing- Image restoration- Fundamentals of image compression; Digital signal processors - Memory architecture- An example DSP architecture

Total Hours : 42 Hours

EE4032 STATIC VAR COMPENSATION AND HARMONIC FILTERING

Pre-requisites: None

L	T	P	C
3	0	0	3

Fundamentals of Load Compensation , Power Quality Issues - Sources of Harmonics in Distribution Systems and Ill Effects .Static Reactive Power Compensators and their control . Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor l, SSSC and its Control, Sub-Synchronous Resonance Transient and Dynamic Stability Improvement in Power Systems - Converters for Static Compensation . Standard Modulation Strategies -GTO Inverters (Multi-Level Inverters)-Passive Harmonic Filtering.

Total Hours: 42 Hours

EE4033 OPTIMAL AND ADAPTIVE CONTROL

Pre-requisites : None

L	T	P	C
3	0	0	3

Optimal control problem - performance measure for linear regulator problem - dynamic programming - discrete linear regulator problem - Hamilton-Jacobi-Bellman equation - continuous linear regulator problem.
Fundamental concepts and theorems of calculus of variations -
Open loop and closed loop form of optimal control - closed loop control for linear regulator problem - linear tracking problem – Pontryagin's minimum principle - state inequality constraints - minimum time problems - minimum control effort problems.
Model following control – Model Reference Adaptive systems (MRAS) - an over view of adaptive control systems - mathematical description of MRAS - design hypothesis - equivalent representation of MRAS - introduction to design method based on the use of Liapunov function

Total Hours: 42 Hours

EE4034 POWER SYSTEM STABILITY AND CONTROL

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Generation Control Loops-Economic Dispatch and AGC-Modeling of power system components-Transient Stability Analysis-Low Frequency Oscillations-Sub Synchronous Resonance -Voltage Stability-Voltage Stability Improvement Methods.

Total Hours: 42 Hours

EE4035 FLEXIBLE AC TRANSMISSION SYSTEMS

Pre-requisites : None

L	T	P	C
3	0	0	3

FACTS Concept and General System Considerations - Converters for Static Compensation. Multi-Level Inverters - Current Control of Inverters. - Static Shunt Compensators. SVC and STATCOM - Static Series Compensation. GCSC, TSSC, TCSC and SSSC - UPFC and IPFC. Special Purpose FACTS Controllers.

Total Hours: 42 Hours

EE4036 NONLINEAR CONTROL THEORY

Pre-requisites: EE3002 Control Systems I , EE4001 Control Systems II

L	T	P	C
3	0	0	3

Classical techniques- Characteristics-types of nonilearities phase plane analysis . perturbation techniques-periodic orbits - stability of periodic solutions - singular perturbation model - slow and fast manifolds. Stability of Nonlinear Systems - Lyapunov stability Centre manifold theorem - region of attraction - Invariance theorems - Input output stability - L stability - L stability of state models - L2 stability- Robust stabilization-.Harmonic Linearisation and Describing Function Method-Harmonic linearization - SIDF- Dual Input Describing function - study of sub-harmonic oscillations. Jump response.-Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion - Popov Criterion– Concepts of Inverse control- - Exact Feedback Linearization - Input state linearization - input output linearization - state feedback control - stabilization - tracking - integral control.

Total Hours: 42 Hours

EE4037 ENERGY AUDITING, CONSERVATION & MANAGEMENT

Pre-requisites : None

L	T	P	C
3	0	0	3

Electrical Systems-Supply & Demand Side-Economic operation, Electric motors-Energy efficient controls and Load Analysis, Variable speed drives-Efficient Control strategies-Optimal operation, Transformer Loading-Efficiency analysis, Feeder and cable loss evaluation, Reactive Power management, Peak Demand controls, Optimal Load scheduling, Energy conservation in Lighting Schemes, Power quality issues, Cogeneration-Types and Schemes, Electric loads of Air conditioning & Refrigeration, case studies

Total Hours: 42 Hours

EE4038 DATA ACQUISITION & SIGNAL CONDITIONING

Pre-requisite: None

L	T	P	C
3	0	0	3

Transducers & Signal Conditioning Data Acquisition Systems(DAS)- Fundamentals of signals acquisition, conditioning and processing. DC Amplifiers. Filtering and Sampling-Sample and Hold Amplifiers Signal Conversion -Data transmission systems,

Total Hours: 42 Hours

EE4039 ADVANCED DC-AC POWER CONVERSION

Pre-requisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Two-Level Voltage Source Inverter - Introduction - Sinusoidal PWM - Space Vector Modulation - Cascaded H-Bridge Multilevel Inverters - H-Bridge Inverter - Bipolar Pulse-Width Modulation - Unipolar Pulse-Width Modulation –Multilevel Inverter Topologies - Carrier Based PWM Schemes -Diode-Clamped Multilevel Inverters - Three-Level Inverter - Neutral-Point Voltage Control - Other Space Vector Modulation Algorithms - High-Level Diode-Clamped Inverters - Other Multilevel Voltage Source Inverters –NPC/H-Bridge Inverter - Multilevel Flying-Capacitor Inverters - PWM Current Source Inverters - Parallel Current Source Inverters

Total Hours: 42 Hours

EE4040 SYSTEM IDENTIFICATION AND PARAMETER ESTIMATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Principles of Modelling and Identification of transfer function- System Identification and Stochastic Modeling-.State Space Models- Distributed parameter models- model structures . identifiability of model structures. - Transfer function from frequency response. Fourier Analysis and Spectral analysis- Pseudo random binary signals . maximum length sequences . Parameter Estimation Methods :linear regression and least squares methods - Recursive methods . RLS Algorithm, Recursive IV Method- Recursive Prediction Error Method - Identification of Multivariable Systems and Closed Loop Systems- reduction of higher order systems aggregation method. Experiment Design and Choice of Identification Criterion: Optimal Input design.

Persistently exciting condition .Choices of Identification criterion- choice of norm - variance: optimal instruments

Total Hours: 42 Hours

EE4041 POWER QUALITY

Pre-requisites: None

L	T	P	C
3	0	0	3

Power Quality – overview of power quality phenomena - Voltage sags – Harmonics - Power factor improvement- Passive Compensation - Passive Filtering- Methods for Single Phase APFC - Three Phase APFC and Control Techniques- Active Harmonic Filtering- Grounding and wiring-introduction - NEC grounding requirements

Total Hours: 42 Hours

EE4042 DIGITAL PROTECTIVE RELAYING

Pre-requisites : None

L	T	P	C
3	0	0	3

Protective Relaying-Standards-Classification, Design–zones and degree of protection, Instrument transformers. Basic elements of digital protection – Relay Schematics and Analysis, Protection of Power System Equipment - Generator, Transformer, Transmission Systems, Busbars, Motors, System grounding – ground faults and protection, algorithms for Numerical relays, Integrated and multifunction protection schemes - SCADA based protection systems, Testing of relays

Total Hours: 42 Hours

EE4094 CONTROL SYSTEMS LABORATORY

Prerequisite: None

L	T	P	C
0	0	3	2

DC Motor Transfer Function-.Amplidyne transfer function & characteristics-FEEDBACK® MS150 DC Modular Servo System-Compensator design and simulation using MATLAB®- PI and PID controllers-Inverted pendulum- Level Process Control Station- Closed loop voltage regulation for a dc separately excited generator using amplidyne and to obtain its characteristics - FEEDBACK® MS150 AC Modular Servo System.(10/12 experiments administered in two cycles).

Total Hours: 42 Hours

DETAILED SYLLABI

ME4104 PRINCIPLES OF MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 hours

Module 1 (9 Hours)
Introduction to management theory, Characteristics of management, Management as an art – profession, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures.

Module 2 (9 Hours)
Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation – communication, Controlling.

Module 3 (12 Hours)
Decision making process – decision making under certainty – risk – uncertainty – models of decision making, Project management – critical path method – programme evaluation and review technique – crashing.

Module 4 (12 Hours)
Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management.

References

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Hicks, *Management: Concepts and Applications*, Cengage Learning, 2007.
3. Mahadevan, B., *Operations Management, Theory and Practice*, Pearson Education Asia, 2009.
4. Kotler, P., Keller, K.L, Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-Mcgraw Hill, 2008.

EE4002: INSTRUMENTATION SYSTEMS

Prerequisites: **EE2001 Signals and Systems,**
EE2008 Analog Electronic Circuit and systems

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Measurement, Instrumentation and Calibration - Introduction to Instrumentation systems - Classification of transducers – performance characteristics, static and dynamic characteristics – Errors in measurement - gross Errors, systematic Errors – statistical Analysis of Random Errors – Calibration and Standards -Process of calibration, classification of standards, standards for calibration.
Signals and their representation.

Module 2: **(10 Hrs)**

Electrical Measuring systems –Measurement of Current, Voltage, Resistance, Impedance. Electronic Amplifiers- difference or Balanced Amplifiers, Electrometer Amplifier, operational Amplifiers, feed back amplifiers, Isolation Amplifiers, charge Amplifiers, power Amplifiers. Measurement of phase Angle- Frequency Measurement – Time – Interval measurement - Dynamics of Instrument systems – generalized performance of systems – electrical Networks – Mechanical systems - Electromechanical systems –Thermal systems – Fluidic systems – Filtering and Dynamic Compensation.

Module 3: **(12 Hrs)**

Basics of Temperature, pressure, Force, Torque, Density, Liquid level, Viscosity, Flow, Displacement, measurement. Passive Electrical Transducers – resistive, Inductive and capacitive Transducers and ,measurement of various physical variables, Active Electrical Transducers – Thermoelectric , piezoelectric , magnetostrictive, Hall – Effect, Electromechanical, Electro Chemical Photoelectric and Ionization Transducers, Digital Transducer, Feed back Transducers Systems –

Module 4: **(10 Hrs)**

Signal processing Circuits – Data Display and recording systems – Data Transmission and Telemetry – Developments in sensor Technology –

Text/Reference Books:

1. D.V.S Murty, Transducers & Instrumentation, prentia Hall of India (pvt ltd), Edition 2, 2008
2. 2. Ernest O. Deobine, Measurement System Application & design, Mcgraw Hill International, Edition 5, 2004.
3. K.B Kalasen, Electronic Measurement & Instrumentation, Cambridge University Press, 1996.
4. Cooper W.D, Modern Electronics Instrumentation, Prentia Hall of India,1996.

EE4031 ADVANCED DIGITAL SIGNAL PROCESSING

Pre-requisite: **EE3005 Digital Signal Processing**

L	T	P	C
3	0	0	3

Total Hours : 42 Hours

Module 1: **(10 Hrs)**

Optimisation Methods for IIR and FIR filter Design:

Deczky's method for IIR filter design in the frequency domain, Pade approximation method , Least- squares design method in time domain; Frequency sampling method for FIR filters, Parksand McClellan Algorithm for design, Remez exchange algorithm for implementation.

Module 2: **(12 Hrs)**

Speech signal processing:

Digital models for speech signal, Mechanism of speech production, Acoustic theory, Lossless tube models , Formulation of LPC equation, Solution of LPC equation, Levinson Durbin algorithm, Schur algorithm, Spectral analysis of speech, Short time fourier analysis, Speech coding, subband coding, Transform coding, Channel vocoder,Formant vocoder, Cepstral vocoder, Vector quantisation coder.

Module 3: **(12 Hrs)**

Two dimensional signal processing(Image Processing)

Digital image representation; 2-D DFT . properties; DCT; Image enhancement ,Spatial and frequency domain filtering methods; colour image processing; Image restoration- Degradation model, Inverse filtering; Fundamentals of image compression.

Module 4: **(8 Hrs)**

Digital signal processors

Introduction to DSP processors- common features, fixed point versus floating point; Memory architecture- Harvard architectures, multiple access memories, multi processor support, addressing modes; instruction set; An example DSP architecture- Analog Devices/Motorola/Texas Instruments

Text/Reference Books:

1. Alan V . Oppenheim, Ronald W. Schafer, .Discrete-Time Signal Processing., Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
2. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing. (third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997
3. L.R. Rabiner and R.W Schafer, Digital processing of speech signals, Prentice Hall, New Jersey , 1978.
4. R. C. Gonzalez and R.E. Woods , Digital Image processing, Addison Wesley, 1992
5. Jae S. Lim, Two Dimensional signal and image processing, Prentice Hall Inc., Englewood Cliffs, New Jersey,1990.
6. Lapsley P, Jeff Bier, Amit Shoham and Lee E. A., DSP Processor Fundamentals ,Architectures and features, IEEE Press.

EE4032 STATIC VAR COMPENSATION AND HARMONIC FILTERING

Pre-requisites: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Fundamentals of Load Compensation , Steady-State Reactive Power Control in Electric Transmission Systems , Reactive Power Compensation and Dynamic Performance of Transmission Systems .
Power Qulity Issues . Sags, Sweels, Unbalance, Flicker , Distortion , Current Harmonics - Sources of Harmonics in DistributionSystems and Ill Effects .

Module 2: **(10 Hrs)**

Static Reactive Power Compensators and their control . Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems

Module 3: **(11 Hrs)**

Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation . Current Control of Inverters.

Module 4: **(11 Hrs)**

Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode . Dynamic Voltage Restorer and its control . Power Quality Conditioner

Text/Reference Books:

1. T.J.E Miller, “Reactive Power Control in Electric Systems”, John Wiley & Sons,1982.
2. N.G. Hingorani & L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press, 2000.
3. Ned Mohan et.al, “Power Electronics”, John Wiley and Sons 2006
4. R. Sastry Vedam & Mulukutla S. Sarma, “Power quality VAR compensation in power systems”, CRC press, 2009.
5. Hirofumi akagi, Edson hirokazu watanabe, Mauricio aredes, “Instantaneous power theory and applications to power conditioning” Wiley Inter Science,2007.
6. K.R. Padiyar, “FACTS controllers in power transmission and distribution”, New age international publications, 2008.

EE4033 OPTIMAL AND ADAPTIVE CONTROL

L	T	P	C
3	0	0	3

Pre-requisites : None

Total Hours: 42 Hours

Module 1: **(10 Hrs)**

Optimal control problem – formulation of performance measure - performance measure for linear regulator problem - dynamic programming - principle of optimality - application to multi stage decision making – application to optimal control problem – need for interpolation - recurrence relation of dynamic programming - curse of dimensionality - discrete linear regulator problem - Hamilton-Jacobi-Bellman equation - continuous linear regulator problem.

Module 2: **(10 Hrs)**

Fundamental concepts and theorems of calculus of variations - Euler - Legrange equation and solution - extremal of functionals of a single function - extremal of functionals of several independent functions - various boundary conditions - extremal of functionals with dependent functions - differential equation constraints – isoperimetric constraints.

Module 3: **(12 Hrs)**

Open loop and closed loop form of optimal control - the variational approach to solving optimal control problems - necessary conditions and boundary conditions for optimal control using *Hamiltonian* – closed loop control for linear regulator problem - linear tracking problem – Pontryagin's minimum principle - state inequality constraints - minimum time problems - minimum control effort problems.

Module 4: **(10 Hrs)**

Model following control – Model Reference Adaptive systems (MRAS) - an over view of adaptive control systems - mathematical description of MRAS - design hypothesis - equivalent representation of MRAS - introduction to design method based on the use of Liapunov function

Text / Reference Books:

1. Donald E. Kirk - Optimal Control Theory, An introduction, Prentice Hall Inc.
2. A.P. Sage - Optimum Systems Control, Prentice Hall.
3. Kwakernaak -Linear optimal control systems . Wiley.
4. HSU and Meyer - Modern Control . Principles and Applications, McGraw Hill.
5. Yoan D. Landu - Adaptive Control - Model Reference Approach, Marcel Dekker.

EE4034 POWER SYSTEM STABILITY AND CONTROL

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Generation Control Loops. AVR Loop. Performance And Response. Automatic Generation Control Of Single Area And Multi Area Systems. Static And Dynamic Response Of AGC Loops . Economic Dispatch And AGC.

Module 2: **(11 Hrs)**

Transient Stability Problem. Modeling Of Synchronous Machine, Loads, Network, Excitation And Systems, Turbine And Governing Systems. Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis. Data For Transient Stability Studies. Transient Stability Enhancement Methods.

Module 3: **(11 Hrs)**

Low Frequency Oscillations. Power System Model For Low Frequency Oscillation Studies. Improvement Of System Damping With Supplementary Excitation Control. Introduction To Sub Synchronous Resonance And Countermeasures.

Module 4: **(9 Hrs)**

Voltage Stability Problem. Real And Reactive Power Flow In Long Transmission Lines . Effect Of ULTC And Load Characteristics On Voltage Stability . Voltage Stability Limit . Voltage Stability Assessment Using PV Curves . Voltage Collapse Proximity Indices. Voltage Stability Improvement Methods.

Text/Reference Books:

1. O.I. Elgard, .Electric Energy System Theory: An Introduction., II Edition, McGraw Hill, New York, 1982.
2. A.J. Wood, B.F. Wollenberg, .Power Generation, Operation And Control., John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. J. Arrilaga, C.P. Arnold, B.J. Harker, .Computer Modeling Of Electrical Power Systems., Wiley, New York, 1983.
4. I.J. Nagrath, O.P. Kothari, .Power System Engineering., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Yao-Nan-Yu, .Electric Power System Dynamics..
6. P. Kundur, .Power System Stability And Control., McGraw Hill, New York, 1994.
7. K.R. Padiyar, .Power System Dynamics . Stability And Control., Interline Publishing (P) Ltd., Bangalore, 1999.
8. C. Van Custem, T. Vournas, .Voltage Stability Of Electric Power Systems., Rlever Academic Press (U.K.), 1999.
9. .B.R. Gupta, .Power System Analysis And Design., III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. T.J.E. Miller, .Reactive Power Control In Electric Power Systems., John Wiley and Sons, New York, 1982.

EE4035 FLEXIBLE AC TRANSMISSION SYSTEMS

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

FACTS concepts and general system considerations: Power flow in AC systems - Definition of FACTS - Power flow control -Constraints of maximum transmission line loading - Benefits of FACTS Transmission line compensation- Uncompensated line -shunt compensation - Series compensation -Phase angle control.

Module 2: **(11 Hrs)**

Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control - Comparison between SVC and STATCOM.

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators - TCVR and TCPAR- Operation and Control –Applications- Modeling and Simulation

Module 3: **(10 Hrs)**

Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- Basic Principle of P and Q control- independent real and reactive power flow control- Applications - Introduction to interline power flow controller.

Module 4: **(10 Hrs)**

Special purpose FACTS controllers - Thyristor controlled voltage limiter - Thyristor controlled voltage regulator - Thyristor controlled braking resistor - Thyristor controlled current limiter-

Custom Power - Compensation Devices - STS - SSC - SVR -Backup energy supply devices, UPQC.

Text/Reference Books:

1. N.G. Hingorani & L. Gyugyi,"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press, 2000..
2. 2.T.J.E Miller, "Reactive Power Control in Electric Systems ",John Wiley & Sons
3. 3.Ned Mohan et.al "Power Electronics", John Wiley and Sons.
4. K. R. Padiyar, "FACTS controllers in power transmission and distribution", New Age International (P) Ltd, 2008.

EE4036 NONLINEAR CONTROL THEORY

Pre-requisites: EE3002 Control Systems I , EE4001 Control Systems II

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(11 Hrs)**

Introduction and classical techniques- Characteristics of nonlinear systems – Types of nonilearities and their occurrences- classification of equilibrium points - limit cycles - analysis of systems with piecewise constant inputs using phase plane analysis . perturbation techniques- periodic orbits - stability of periodic solutions - singular perturbation model - slow and fast manifolds.

Module 2: **(10 Hrs)**

Stability of Nonlinear Systems - Lyapunov stability - local stability - local linearization and stability in the small- Direct method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems - variable gradient method - Centre manifold theorem - region of attraction - Invariance theorems - Input output stability - L stability - L stability of state models - L2 stability- Robust stabilization.

Module 3: **(10 Hrs)**

Harmonic Linearisation and Describing Function Method-Harmonic linearization - filter hypothesis - Sine Input describing function of standard nonlinearities- study of limit cycles (amplitude and frequency) using SIDF- Dual Input Describing function - study of sub-harmonic oscillations. Jump response.

Module 4: **(11 Hrs)**

Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion - Popov Criterion– Concepts of Inverse control-Feedback linearization-Model predictive control-Simultaneous Feedback control-Design via linearization- stabilization - regulation via intgral control- gain scheduling - Exact Feedback Linearization - Input state linearization - input output linearization - state feedback control - stabilization - tracking - integral control.

Text/Reference Books:

1. Hassan K Khalil, *Nonlinear Systems*, Prentice - Hall International (UK), 1996
2. JJE Slotine & W.LI .Applied Nonlinear Control. Prentice Hall, Englewood Clifs, New Jersey 1991
3. Alberto Isidori, *Nonlinear Control Systems*, Springer Verlag, 1995

EE4037 ENERGY AUDITING, CONSERVATION & MANAGEMENT

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(9 Hrs)**

Electrical Systems: Supply & Demand Side, Economic operation, Input-Output curves, Load profiling,Electricity tariff types; Energy auditing: Types and objectives-audit instruments- ECO assessment and Economic methods-specific energy analysis

Module 2: **(11 Hrs)**

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors.

Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Optimal operation and Storage; Case study

Module 3: **(11 Hrs)**

Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.

Reactive Power management-Capacitor Sizing-Degree of Compensation, Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study;

Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study;

Module 4: **(11 Hrs)**

Cogeneration-Types and Schemes;

Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage .Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- softwares-EMS

Text/Reference Books:

1. Rik DeGunther, “Alternative energy for dummies”, John Wiley & Sons, May 2010.
2. Paul A. Lynn, “Electricity from sunlight”, John Wiley & Sons, July 2010
3. Leon K. Kirchmayer, “Economic Operation of power system”, Wiley India Pvt Ltd, July 2010.
4. Jean-Claude SabonnadiAre, “Low emission power generation technologies and energy management”, John Wiley & Sons, August 2010
5. Ursula Eicker, “Low energy cooling for sustainable buildings”, John Wiley & Sons, August 2010
6. Allen J. Wood, “ Power generation Operation and Control”, Wiley 2nd edition, August 2010.
7. Timothy J. E. Miller, “Reactive power control in electric systems”, Wiley edition, August 2010
8. Paul C. Crause, Oleg Wasynczuk, Scott D.sudhoff, “Analysis of electric machinery and drive system” , Wiley 2nd Edition, August 2010.
9. Marion Pagliaro, Giovanni Palmisano Rosaria Ciriminna, “Flexible Solar Cells”, John Wiley & Sons, November 2009.
10. Alexander Mitsos, Paul I.Barton, “Microfabricated Power Generation Devices”, John Wiley & Sons, March 2009.
11. Albert Thumann, P.W,Plant Engineers and Managers Guide to Energy Conservation” TWI Press Inc, Terre Haute, 9th edition,2008
12. Roland Wengenmayr, “Renewable Energy”, John Wiley & Sons, April 2004
13. Francois, Leveque, “Transport pricing of electricity networks”, Springer 2003.
14. Parasiliti F., P. Bertoldi, “Energy Efficiency in motor driven systems”, Springer, 2003.
15. Turner, Wayne C., “Energy Management Handbook”, Lilburn, The Fairmont Press, 2001
16. Donald R. W., “Energy Efficiency Manual”, Energy Institute Press,2000
17. Giovanni Petrecca, “.Industrial Energy Management: Principles and Applications”, The Kluwer international series -207,1999 Springer 2000.
18. Anthony J. Pansini, Kenneth D. Smalling, “Guide to Electric Load Management”, Pennwell Pub,1998
19. Albert Thumann , “Handbook of Energy Audits”, Fairmont Pr; 5th edition,1998

20. Howard E. Jordan, “Energy-Efficient Electric Motors and Their Applications”, Plenum Pub Corp; 2nd edition 1994
21. Petrecca, Giovanni, “Industrial Energy Management”, Springer 1993
22. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities”, IEEE Inc, USA.,1985
23. Partab H., “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Sons, New Delhi, 2nd edition,
24. Tripathy S.C, “Electric Energy Utilization And Conservation”, Tata McGraw Hill.
25. NESCAP-Guide Book on Promotion of Sustainable Energy Consumption

EE4038 DATA ACQUISITION & SIGNAL CONDITIONING

Pre-requisite: None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Transducers & Signal Conditioning (10 Hrs)

Data Acquisition Systems(DAS)- Introduction – Fundamentals of signals acquisition, conditioning and processing. -Objectives of DAS . Block Diagram Description of DAS- General configurations - Single and multichannel DAS-Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors) – Signal Conditioning: Requirements - Instrumentation amplifiers: Basic characteristics . Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Transmitters .Optical Fiber Based Signal Transmission-Piezoelectric Couplers- Intelligent transmitters.

Module 2: Filtering and Sampling (12 Hrs)

Review of Nyquist.s Sampling Theorem-Aliasing . Need for Prefiltering-First and second order filters - classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters . Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

Module 3: Signal Conversion (12 Hrs)

Analog-to-Digital Converters(ADC)-Multiplexers and demultiplexers - Digital multiplexer . A/D Conversion . Conversion Processes , Speed, Quantization Errors . Successive Approximation ADC . Dual Slope ADC . Flash ADC . Digital-to-Analog Conversion(DAC) . Techniques, Speed, Conversion Errors, Post Filtering- Weighted Resistor, R-2R, Weighted Current type of DACs- Multiplying Type DAC-Bipolar DACs

Module 4: Data Transmission (8 Hrs)

Data transmission systems- Analog transmission system, Digital transmission system,
Analog encoding of analog information, Analog encoding of digital Information, Digital encoding of analog information, Digital encoding of digital information, Schmitt Trigger-Pulse code formats- Modulation techniques and systems-Telemetry systems.

Text/Reference Books:

1. Ernest O Doeblin., Measurement Systems: Application and Design, McGraw Hill (Int. edition) 1990
2. George C.Barney, Intelligent Instrumentation, Prentice Hall of India Pvt Ltd., New Delhi, 1988.
3. Ibrahim, K.E., Instruments and Automatic Test Equipment, Longman Scientific & Technical Group Ltd., UK, 1988.
4. G.B. Clayton, .Operational Amplifiers, Butterworth &Co, 1992
5. Oliver Cage, .Electronic Measurements and Instrumentation., McGraw-Hill, (Int. edition) 1975

EE4039 ADVANCED DC-AC POWER CONVERSION

Pre-requisite: EE3007 Power Electronics

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: Two-Level Voltage Source Inverter (10 Hrs)

Introduction **- Sinusoidal PWM -** Modulation Scheme - Harmonic Content – Over-modulation - Third Harmonic Injection PWM - **Space Vector Modulation** - Switching States - Space Vectors - Dwell Time Calculation - Modulation Index - Switching Sequence - Spectrum Analysis - Even-Order Harmonic Elimination - Discontinuous Space Vector Modulation

Module 2: Cascaded H-Bridge (CHB) Multilevel Inverters (9 Hrs)

Introduction **- H-Bridge Inverter** - Bipolar Pulse-Width Modulation - Unipolar Pulse-Width Modulation – **Multilevel Inverter Topologies -** CHB Inverter with Equal dc Voltage - H-Bridges with Unequal dc Voltages. **Carrier Based PWM Schemes** - Phase-Shifted Multicarrier Modulation - Level-Shifted Multicarrier Modulation - Comparison Between Phase- and Level-Shifted PWM Schemes - Staircase Modulation.

Module 3: Diode-Clamped Multilevel Inverters (13 Hrs)

Introduction **-Three-Level Inverter -** Converter Configuration - Switching State - Commutation - Space Vector Modulation - Stationary Space Vectors - Dwell Time Calculation - Relationship Between V_{ref} Location and Dwell Times - Switching Sequence Design -Inverter Output Waveforms and Harmonic Content - Even-Order Harmonic Elimination - **Neutral-Point Voltage Control** - Causes of Neutral-Point Voltage Deviation - Effect of Motoring and Regenerative Operation - Feedback Control of Neutral-Point Voltage - **Other Space Vector Modulation Algorithms** - Discontinuous Space Vector Modulation - SVM Based on Two-level Algorithm **High-Level Diode-Clamped Inverters** - Four- and Five-Level Diode-Clamped Inverters - Carrier-Based PWM – **Other Multilevel Voltage Source Inverters – Introduction - NPC/H-Bridge Inverter - Inverter** Topology - Modulation Scheme - Waveforms and Harmonic Content - **Multilevel Flying-Capacitor Inverters** - Inverter Configuration - Modulation Schemes

Module 4: PWM Current Source Inverters (10 Hrs)

Introduction **-** PWM Current Source Inverter - Trapezoidal Modulation - Selective Harmonic Elimination - **Space Vector Modulation** - Switching States - Space Vectors - Dwell Time Calculation - Switching Sequence - Harmonic Content - SVM Versus TPWM and SHE - **Parallel Current Source Inverters** - Inverter Topology - Space Vector Modulation for Parallel Inverters - Effect of Medium Vectors on dc Currents - dc Current Balance Control - Load-Commutated Inverter (LCI)

Text/Reference Books:

1. B. Woo, “High Power Converters and AC Drives”, John Wiley & Sons, 2006
2. Ned Mohan et.al , “Power Electronics” ,John Wiley and Sons,2006
3. Rashid, “Power Electronics, Circuits Devices and Applications”, Pearson Education, 3rd edition, 2004.
4. G.K.Dubey, Thyristorised Power Controllers, Wiley Eastern Ltd, 1993.
5. Dewan & Straughen, Power Semiconductor Circuits, John Wiley & Sons, 1975.
6. Cyril W Lander, Power Electronics, Mc Graw Hill, 3rd edition, 1993.

EE4040 SYSTEM IDENTIFICATION AND PARAMETER ESTIMATION

Pre-requisites : None

L	T	P	C
3	0	0	3

Total Hours: 42 Hours

Module 1: **(14 Hrs)**

Principles of Modelling and Identification of transfer function

System Identification and Stochastic Modeling- Structure and parameter estimation . properties of estimates - validation of models-impulse Response. Step Response . Frequency response- transfer function from these.- disturbances and transfer function .State Space Models- Distributed parameter models- model structures . identifiability of model structures. signal spectra . single realization and ergodicity . multivariable systems.- Transfer function from frequency response. Fourier Analysis and Spectral analysis- Estimating Disturbance Spectrum . Correlation Identification . Practical Implementation . Pseudo random binary signals . maximum length sequences . generation using hardware . random number generation on digital computer

Module 2: **(10 Hrs)**

Parameter Estimation Methods

Guiding principles behind parameter estimation methods . minimizing prediction errors . linear regression and least squares methods . statistical framework for parameter estimation . maximum likelihood estimation . correlating prediction errors with past data . Instrumental variable method . consistency and identifiability- Recursive methods . RLS Algorithm, Recursive IV Method- Recursive Prediction Error Method . Recursive pseudo-linear regressions . choice of updating step

Module 3: **(10 Hrs)**

Identification of Multivariable Systems and Closed Loop Systems-Transfer function matrix representation of MVS- state space method input output difference equation method - canonical models for MVS . comparison of different models . identification of continuus MV systems from input output data.Identification of closed loop systems . reduction of higher order systems . aggregation method . aggregation with partial realization . singular perturbation method . optimum approximation . comparison of different methods of model reduction.

Module 4: **(8 Hours)**

Experiment Design and Choice of Identification Criterion

Optimal Input design . Persistently exciting condition . optimal input design for higher order black box models . choice of sampling interval and presampling filters .Choices of Identification criterion . choice of norm . variance: optimal instruments

Text/Reference Books:

1. System Identification Theory for The User : Lennart Ljung , Prentice Hall Information Systems Science Series (1987)
2. Sinha N K , Kuztsa : System Identification And Modeling of Systems(1983)
3. Harold W Sorensen : Parameter Estimation : Marcel Dekker Inc, New York. 1980, Advances in Control Systems series
4. Daniel Graupe :Identification of Systems : Van Nostrand

EE4041 POWER QUALITY

L	T	P	C
3	0	0	3

Pre-requisites: None

Total Hours: 42 Hours

Module 1: **(9 Hrs)**

Power Quality –overview of power quality phenomena -Basic terminologies –Power Quality Issues – Causes for reduction in Power Quality — Power Quality Standards and indices.

Module 2: **(11 Hrs)**

Voltage sags-Causes of voltage sags – magnitude & duration of voltage sags – effect on drives and peripherals– monitoring & mitigation of voltage sags.

Interruptions -Origin of Long & Short interruptions – influence on various equipments – monitoring & mitigation of interruptions.

Harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Module 3: **(11Hrs)**

Power factor improvement- Passive Compensation- Passive Filtering- Harmonic Resonance - Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End-Control Methods for Single Phase APFC-Three Phase APFC and Control Techniques- PFC Based on Bilateral Single Phase and Three Phase Converter-static var compensators-SVC and STATCOM

Module 4: **(11Hrs)**

Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four-wire systems-d-q domain control of three phase shunt active filters -UPS-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.

Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

Text/Reference Books:

1. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991
2. Math H. Bollen , “Understanding Power Quality Problems”, IEEE Press, 1st Edition,2001
3. J. Arrillaga, “Power System Quality Assessment”, John Wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood, Power system Harmonic Analysis, Wiley, 1997
5. Wilson E Kazibwe, Musoke H Sendaula, “Electic Power quality control techniques”, Van Nostrand Reinhold , NewYork,1993
6. J. Schlabbach,D. Blume,T. Stephanblome , “Voltage quality in Electrical Power Systems”,IEE, 2001.
7. Roger c. Dugan/ Mrak F. McGranaghan, Surya santoso & H. Wayne Beaty, “Electrical power systems quality”, Tata Mc Graw-Hill,2010.
8. George J. Walkilesh, “Power Systems Harmonics”, springer,2007.
9. R. Sastry Vedam & Mulukutla S. Sarma, “Power quality VAR compensation in power systems”, CRC press, 2009.
10. Angelo Baggini, “ Handbook of power quality”, Wiley,2008.

EE4042 DIGITAL PROTECTIVE RELAYING

Pre-requisites : None

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

Module 1: **(8 Hrs)**

Protective Relaying - Qualities of relaying - Definitions - Codes- Standards; Characteristic Functions; Classification –analog-digital- numerical; schemes and design-factors affecting performance –zones and degree of protection; faults-types and evaluation; Instrument transformers for protection.

Module 2: **(12 Hrs)**

Basic relay units-sequence networks-fault sensing data processing units- FFT and Wavelet based algorithms - Phase& Amplitude Comparators-. Duality - Zero Crossing/Level Detectors; Relay Schematics and Analysis- Over Current Relay- Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays- Restraining Characteristics; Distance Relays: Types- Characteristics;

Module 3: **(12 Hrs)**

Protection of Power System Equipment - Generator, Transformer, Generator- Transformer Units, Transmission Systems, Busbars, Motors; Pilotwire and Carrier Current Schemes;
System grounding –ground faults and protection; Load shedding and frequency relaying; Out of step relaying ; Re-closing and synchronizing

Module 4: **(10 Hrs)**

Numerical relays - Characteristics -Functional Diagrams-architecture - algorithms -Microprocessor & DSP based relays- sampling –aliasing –filter principles;
Integrated and multifunction protection schemes -SCADA based protection systems- FTA; Testing of Relays.

Text/Reference Books:

1. C.R. Mason, The art and science of protective relaying, John Wiley &sons.
2. A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall.
3. T.S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill Publication.
4. Power System Protection Vol. I, II , III&IV, The Institution Of Electrical Engineers, Electricity Association Services Ltd., 1995
5. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marcel Dekker, Inc.
6. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw Hill.
7. Blackburn, J. Lewis ,Protective Relaying, Principles and Applications, Marcel Dekker, Inc., 1986.
8. Anderson, P.M, Power System Protection,. McGraw-Hill, 1999
9. Singh L.P ,Digital Protection, Protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1994
10. Wright, A. and Christopoulos, C, Electrical Power System Protection,. Chapman & Hall, 1993,
11. Walter A. Elmore, J. L. Blackburn, Protective Relaying Theory and Applications, ABB T&D Co. Marcel Dekker, Inc.
12. Arun G. Phadke, James S. Thorp, Computer Relaying for Power Systems, Marcel Dekker, Inc.

EE4094 CONTROL SYSTEMS LABORATORY

Prerequisite: None

L	T	P	C
0	0	3	2

Total Hours: 42 Hours

List of experiments:

1. To obtain the moment of inertia and develop the transfer function of the given DC Motor for (a) Armature controlled and (b) Field controlled cases. Draw the relevant block diagrams.
2. To conduct experiments on the given amplidyne for (a) To obtain the transfer function (b)To obtain the load characteristics under different levels of compensation (c) To obtain the characteristics of a metadyne.
3. To Study the FEEDBACK® MS150 DC Modular Servo System and to obtain the characteristics of the constituent components. Also to set up a closed loop position control system and study the system performance.
4. To design a Lead compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
5. To design a Lag compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
6. To design a Lag-Lead compensator and to obtain the characteristics by experiment and simulation using MATLAB®.
7. To set up a system for closed loop voltage regulation for a dc separately excited generator using amplidyne and to obtain its characteristics.
8. To obtain the model of the Inverted pendulum and study the closed loop performance using experiments on Bytronic® Inverted Pendulum
9. To obtain the characteristics of the synchro systems and to set up a synchro link position control system using FEEDBACK® MS150 AC Modular Servo.
10. To set up a closed loop feedback control system using the FEEDBACK® MS150 DC Modular Servo System-with velocity (rate) feed back.
11. To conduct experiments on the Level Process Control Station and to study the working of a level control loop.
12. To set up a closed loop feedback control system using the FEEDBACK® MS150 AC Modular Servo System-with velocity (rate) feed back.

[Note: Normally the practical classes are administered in two cycles. Depending on the availability of equipments and time, class coordinators may choose the experiments for each cycle.]

Text/Reference Books:

1. Gene F Franklin, J David Powell, Abbas Emami Naeini, *Feedback Control of Dynamic Systems,* 4th Ed, Pearson Education Asia, 2002
2. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, *Control System Design*, Prentice Hall India, 2003.
3. John J D'Azzo, Constantine H Houpis, Stuart N. Sheldon, *Linear Control System Analysis & Design with MATLAB*, 5th Ed, Marcel Dekker, 2003
4. P.C. Sen, *Principles of Electrical Machines & Power Electronics*, John Wiley, 2003.
5. John E Gibson, Franz B. Tuteur, Control System Components, McGrawHill, 1958.
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