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

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

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

Total Hours: 42 Hours

L	T	P	C
3	0	0	3

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