NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
BTECH SYLLABUS

3RD SEMESTER

EEL 1301 SIGNALS, SYSTEMS AND NETWORKS 3-1-0-8

1. **Signals and Systems:** classification of signals; signal operations: scaling, shifting and inversion; signal properties: symmetry, periodicity and absolute integrability, elementary signals, classification of systems; system properties: linearity, time/shift-invariance, causality, stability; continuous-time linear time invariant (LTI) and discrete-time linear shift invariant (LSI) systems: impulse response and step response; response to an arbitrary input: convolution; system representation using differential and difference equations; Eigen functions of LTI/ LSI systems, frequency response and its relation to the impulse response. LECTURES:8

2. **Network Theorems:** Superposition theorem, maximum power transfer theorem, reciprocity theorem, Millman's theorem, substitution theorem, compensation theorem, Tellegen's theorem, all theorems using examples of AC networks. LECTURES:8

3. **Transient Analysis and Resonance:** Introduction of transient phenomena, initial conditions and analysis of RL, RC and RLC circuits; series resonance, parallel resonance and comparison of series and parallel resonant circuits. LECTURES:6

4. **Two Port Network:** One port and two port network, Sign convention, Admittance Parameter, Parallel connection of two port network, Impedance parameter, Series connection of two-port network. Hybrid parameters, Inverse Hybrid parameters, Transmission parameters, Inverse Transmission parameters, Concept of driving point impedance and admittance, Symmetrical two ports and bisection, Image impedance. LECTURES:8

5. **Graph Theory :** Graph of a network, Trees, Co-trees, Loops, Incidence matrix, cut-set matrix, Ties matrix and loop currents, Number of possible trees of a Graph, Analysis of Net works, Network Equilibrium Equation, Duality, General network transformation. LECTURES:4

6. **Application of Laplace Transform:** Brief review of Laplace transform technique, Initial and final value Theorem, Solution of circuit transient using Laplace transform. Use of Laplace's transform in electrical circuit analysis.
LECTURES:6

7. **Fourier Analysis:** Trigonometric Fourier Series, Evaluation of Fourier Coefficients, Waveform Symmetry, Exponential form, Fourier transform techniques applied in networks. LECTURES:4

8. **Filter Circuits:** Classification of filters, equation of an ideal filter, Theory of pie section, Constant K-type filters, low pass filters, design of low pass filter, high pass filters, band pass filters, band rejection filters and all pass filters. M derived filters, theory of M-derived filters, M-derives low pass and high pass filters. Approximation theory of filters (Butter worth and Chebyshev). LECTURES: 6

Readings:

Prescribed Text Books

1. Hayt & Kemmerly, Engineering Circuit Analysis, Mc Graw Hill.
2. Roy Choudhury, Network and Systems, New Age

Additional Readings

1. Rajeswaran, Electric circuit Theory, Pearson publications.
2. Wadhwa, Network analysis and synthesis, New Age Publication
3. Soni and Gupta, A Course in Electrical Circuit Analysis, Dhanpat Rai & Sons
4.Van Valkenburg, Network Analysis & Synthesis, PHI publications

EEP 1301 CIRCUITS & NETWORK LABORATORY 0-0-3-3

1. Transient response in R-L and R-C Network: Simulation/hardware

2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware

3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network

4. Frequency response of LP and HP filters

5. Frequency response of BP and BR filters

6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form

7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB

8. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB

9. Determination of Laplace transform and inverse Laplace transformation using MATLAB

10. Spectrum analysis of different signals

Text/References:

1. Hayt & Kemmerly, Engineering Circuit Analysis, Mc Graw Hill.
2. Roy Choudhury, Network and Systems, New Age

EEL1302 ELECTROMAGNETIC FIELD THEORY 3-0-0-6

1. Introduction to Vector Calculus: DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields. LECTURES:4

2. Co-ordinate Systems: Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems. LECTURES:3

3. Electrostatic Field: Coulomb's law, field intensity, Gauss's law, Electric potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field. Boundary conditions: Dielectric-dielectric, Conductor –dielectric, Conductor-free space. Poisson's and Laplace's equation, General procedure for solving Poisson's and Laplace's equation. LECTURES:8

4. Magneto Static Field: Biot- Savart law, Ampere's circuit law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments, Magnetisation in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material. LECTURES:8

5. Electromagnetic Fields: Faraday's law, Transformer and motional emf, Displacement current, Maxwell's equations, Time varying Potential, Time harmonic fields. LECTURES:4

6. Electromagnetic Wave Propagation: Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Polarisation. Transmission line equation & solutions, Physical significance of solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation.
LECTURES:13

Readings:

Prescribed Text Books

1. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2000.
2. D. K. Cheng, Field and Wave Electromagnetics, Pearson, 2001.

Additional Readings

1. R. K. Shevgaonkar, Electromagnetic Waves; McGraw Hill, 2006.
2. R. F. Harrington, Time-Harmonic Electromagnetic Fields, Wiley-IEEE, 2001.
3. N. Ida, Engineering Electromagnetics, Springer, 2000.

4TH SEMESTER

EEL1401 ELECTRICAL MACHINES-I 3-1-0-8

1. Electromagnetism: Electromagnetism, effect of magnetic field on current carrying conductor, magnetic circuit, magnetising curve, characteristics of magnetic material, electromagnetic induction, excitation to magnetic circuit, hysteresis and eddy current losses, energy stored in magnetic circuit, mmf, mutual inductance and transformer.
LECTURES:6

2. Transformer: Emf equation, relation between voltage per turn and KVA output, phasor diagram based on approx. and exact equivalent circuit, per unit equivalent resistance reactance, open circuit and short circuit tests, back to back test, regulation, losses and efficiency, max. efficiency, all day efficiency, wall cooling; two winding and three winding transformers, auto transformer, phase transformation and connections, parallel operation. LECTURES:6

3. DC Generators: Classification on methods of excitation, armature reaction, interpoles and compensating winding, commutation, load characteristics of DC generators, regulation, parallel operation. LECTURES:8

4. DC Motors: Torque equation, characteristic curves of shunt, series and compound motors, starting starter and grading of starting resistance, speed control – armature voltage control and field control methods; Ward Leonard method, choice of motors for different duties, losses and efficiency, testing- Swinburn's test, back to back test, retardation test and brake test. LECTURES:8

5. Polyphase Induction Motor: Operation of polyphase induction motors, effect of slots on performance of the motor, equivalent circuit and phasor diagram, locus diagrams, torque and power, speed – torque curve – effect of rotor resistance, deep bar and double cage rotors, performance calculation from circle diagram, methods of speed control, testing, losses and efficiency, slip power recovery schemes application, induction generators and induction regulator. LECTURES:8

Readings:

Prescribed Text Books

1. S. Chapman, Electric Machinery Fundamentals,McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, Electrical Machines, Laxmi Publications(P) Ltd., 2003.

Additional Readings

1. I. L. Kosow, Electrical Machinery and Transformers, Prentice- Hall of India Pvt. Ltd., 2003
2. B. S. Guru and H. R. Hiziroglu, Electrical Machinery and Transformers, Oxford University Press, 2003.

EEP1401 ELECTRICAL MACHINES-I LABORATORY 0-0-3-3

1. To pre determine the efficiency and regulation of a Transformer by conducting open circuit and short circuit test and to draw the equivalent circuit.
2. To study and verify the operating characteristics of a DC Series motor

3 To study and verify the speed control of a DC Series motor by Armature resistance control
4. To study and verify the speed control of a DC Series motor by Field divertor method
5. Study of load characteristics of DC Shunt Generator

6. Study of no-load and load characteristics of a Separately excited DC Shunt motor and draw N-T & N-Ia characteristics
7. Speed control of separately excited DC shunt motor by Armature Voltage control.

8. To study and verify the Load characteristics of Short Shunt DC compound motor
   (a) Armature voltage control
   (b) Field Current control
9. To study and verify the load characteristics of Long Shunt DC compound Motor .

Text/References:

1. S. Chapman, Electric Machinery Fundamentals,McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, Laxmi Publications (P) Ltd., 2003

EEL1402 ELECTRICAL AND ELECTRONIC MEASUREMENTS 3-0-0-6

1. Introduction: Introduction of signals, measurement and instruments, static and dynamic characteristics of instruments; different types of instruments; operating forces required for working of indicating instruments; different types of damping and

control systems; construction and working principles of PMMC, MI, induction type and electrodynamometer type instruments, Galvanometer and their applications advantages and disadvantages. LECTURES:8

2. Bridges For Measurements: Measurement of resistance (law) by kelvin's Double bridge method, insulation resistance by loss of charge method; A.C. and D.C. bridges - Maxwell's commutated D.C. bridge, Anderson bridge, Schering Bridge, Hay's Bridge, Wagner Earthing device, Campbell's Mutual Inductance Bridge, circuit diagram, phasor diagram, derivations of equations for unknown, O-factor, dissipation factor, advantages and disadvantages. LECTURES:8

3. Potentiometers: Standardization, principle of working and construction of Crompton, polar and co-ordinate type potentiometers. LECTURES:2

4. Measurement of Power, Power Factor and Energy: Measurement of power and energy, use of current transformer and potential transformer, electrodynamometer type of wattmeter, induction type energy meter, indicating type frequency meter, electrodynamometer type p.f. meter. LECTURES:4

5. Electronic Instruments: Introduction, electronic voltmeters-advantages, types. differential amplifier; DC voltmeter. Electronic voltmeters using rectifiers. Electronic multimeters, electronic ohmmeter. Consideration in selecting an analog voltmeter; differential voltmeter.AC voltage measurement, AC and DC current measurement using electronic instrument. LECTURES:6

6. Cathode Ray Oscilloscope and Signal Analyzer: Advantages & disadvantages of digital instruments over analog instruments; digital multimeter and description and field of application, C.R.O.—block diagram representation and operation, applications; use of dual trace oscilloscope; function generator—working principle with block diagram; frequency counter-working principle with block diagram**.** LECTURES:4

7. Measurement of Non-electrical Quantities: Concept of measurement using transducers as input element, active &passive transducers—differences. study of the following transducers: piezo-electric crystal. Thermistor, thermocouple. Strainguage. LVDT. DC and AC tachogenerators. LECTURES:4

Readings:

Prescribed Text Books

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2012.
2. E.W. Golding. And F.C.Widdis A Text Book of Electrical Measurement and Measuring Instruments, Wheeler Publications, 1968.

3. D. Cooper and A.D. Heifrick, Modern electronic instrumentation and measuring techniques, PHI, 2009.

Additional Readings

1. R. A. Witte, Electronic Test Instruments, Pearson Education, 2002.
2. B. E. Jones, Instrumentation, Measurement and Feedback, Tata McGraw-Hill, 2000.
3. R. P. Areny and T. G. Webster, Sensors and Signal Conditioning, Wiley-Interscience, 2000.
4. C. F. Coombs, Electronic Instruments Handbook, McGraw-Hill, 2000.

EEP1402 ELECTRICAL AND ELECTRONIC MEASUREMENTS LAB 0-0-3-3

1. Measurement of medium resistance using portable Wheatstone bridge.
2. Measurement of inductance using hay's bridge.
3. Measurement of inductance using Maxwell Inductance Bridge.
4. Measurement of low resistance using Kelvin double bridge.
5. Study and calibration of single phase energy meter.
6. Using lissajous figures to measure phase and frequency.
7. Measurement of power using ammeter voltmeter .
8. Study of the range extension of an ammeter.
9. Measurement of capacitance using Schering Bridge.
10. Measurements of three phase power using two wattmeter method.
11. Calibration of voltmeter using potentiometer
12. Measurement power factor, frequency by using electronic method.
13. Study of Digital Multimeter, LC R meter, DSO.

Text/References:

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2012.
2. E.W. Golding. And F.C.Widdis A Text Book of Electrical Measurement and Measuring Instruments, Wheeler Publications, 1968.

5TH SEMESTER

EEL1501 ELECTRICAL MACHINES-II 3-0-0-6

1. Synchronous Machine (SM): General principles and types: armature reaction, leakage reactance, synchronous reactance, and impedance of non-salient pole SM, steady state model, open circuit and short circuit tests, short circuit ratio, nature of MMF in non-salient and salient pole m/c, determination of regulation by synchronous

impedance method, MMF methods, and ASA method, and efficiency. LECTURES:10

2. Salient Pole Synchronous Machines: Two-reaction theory; slip test, regulation; damper winding and oscillation; synchronizing power; determination of transient and sub-transient reactances and sequence impedances; parallel operation. LECTURES:5

3. Synchronous Motors: Phasor diagram, effect of excitation variation, V-curve, O-curve; power-angle diagram & stability, hunting; methods of starting, application as phase modifier. LECTURES:5

4. Single Phase Commutator Motors: Series, repulsion and universal motors – construction, principle of operation, commutation, starting methods; speed control; power factor and methods of compensation. LECTURES:8

5. Single Phase Induction Motors: Construction, analysis of starting and running characteristics; starting methods. LECTURES:4

6. Linear Induction Motors: Introduction, operating principles and application areas. LECTURES:4

7. Stepper Motor: Construction, torque-stepping rate characteristics, application areas. LECTURES:6

Readings:

Prescribed Text Books

1. S. Chapman, Electric Machinery Fundamentals, 4/e, McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, 3/e, Laxmi Publications (P) Ltd., 2003.

Additional Readings

1. S.K. Sen, Electrical Machinery, Khanna Publishers, 2002
2. P.S. Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers, 2002
3. D. P. Kothari, I. J. Nagrath, Electrical Machines, TMH, 2004
4. A.S. Langsdorf, Theory of A.C. Machines,TMH, 2001

EEP1501 ELECTRICAL MACHINES –II LABORATORY 0-0-3-3

1. Study of NO-Load test on a Three phase Induction Motor.

2. Study of Block Rotor test on a Three phase Induction Motor.

3. Study of NO-Load test on a single phase Induction Motor.

4. Study of Block Rotor test on a single phase Induction Motor.

5. Study of Load test on a single phase Induction Motor.

6. To study the Open & Short circuit characteristics of Three Phase Synchronous Generator.

7. Study of V- curve of Three Phase Synchronous motor.

8. Study of Synchronising and parallel operation of Synchronous Generator.

9. Study of Slip test of synchronous machines.

Text/References:

1.S.Chapman, Electric Machinery Fundamentals, 4/e, McGraw-Hill, 2003.
2. R. K. Rajput, Electrical Machines, 3/e, Laxmi Publications (P) Ltd., 2003.

EEL1502 POWER SYSTEMS-I 3-0-0-6

1. Introduction of Generation: Generation of electrical energy, sources of energy, comparison of different sources of power. LECTURES:2

2. Economics of Power Systems: Definitions of load, connected load, demand, peak load, demand intervals, demand factor, average load, load factor, diversity factors, utilization factor, capacity factor, load curves, base load, and peak load; calculations based on the above factors; economics of power factor improvement; tariffs: structures, calculation on tariff and economics of power factor improvement. LECTURES:6

3. Transmission Systems: Introduction to transmission system (TS); advantages of high voltage transmission; comparison of AC and DC transmission system; comparison of conductor materials of various overhead systems; economic choice of conductor size, Kelvin's law. Classification of transmission lines; performance of short and medium transmission lines, nominal T and nominal π methods; performance of long transmission lines. LECTURES:7

4. Distribution Systems: Introduction to distribution system (DS); classification of DS; feeders, distributors, service mains of a typical DS; classification of AC DS; connection schemes of DS; methods of calculations of AC DS; current loading and voltage drop diagram. LECTURES:2

5. Line Constants: Introduction to overhead line (OHL) constants; inductance: inductance of solid cylindrical conductor, composite conductors, two conductor single phase line, three phase single circuit and double circuit lines with symmetrical and

unsymmetrical spacing, transposed and untransposed line, skin and proximity effects; LECTURES:5

6.Capacitance: Concept, potential difference between two points due to charge, capacitance of two wire line, three phase symmetrical and unsymmetrical line, charging current, effect of earth on capacitance of transmission line. LECTURES:4

7. Mechanical Design: Introduction to mechanical design; towers: classification; cross arm: functions, types; insulators: functions, types; vibration damper; guy wires; turn buckle; danger plat etc. calculation of sag, ice and wind loading; stringing chart, sag template; voltage distribution of over suspension insulators, string efficiency, methods of improving string efficiency; corona: disruptive critical and visual critical voltages, factors effecting corona, corona power loss; advantages and disadvantages of corona, radio interference. LECTURES:10

8. Underground Cables: Insulator materials; construction of single core and three core cables; classification of cables and their construction; laying of cables; jointing of cables; stress and capacitance of single core and three core cables; most economical size of conductor; grading of cables; types of grading; breakdown voltages and mechanism of breakdown, thermal characteristics of cables; comparison of overhead and underground supply system. LECTURES:4

Readings:

Prescribed Text Books

1. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
2. A. Hussain, Electrical Power System, CBS Publishers,2007
3. B.R.Gupta, Generation of Electrical Energy, S. Chand & Co. 2009

Additional Readings

1. M.LSoni, P.V Gupta, U.S Bhatnagar, Electric Power, Dhanpat Rai & Sons, 1984
2. J.B.Gupta, A course in Power Systems, S. K. Kataria & Sons, 2002
3. O.I.Elgerd Electric Energy system Theory - An Introduction Tata Mcgraw Hilll, 2002

EEP1502 POWER SYSTEMS-I LABORATORY 0-0-3-3

1. Determination of transmission line parameters.
2. Formation of Bus Admittance and Impedance Matrices.
3. Simulation of fault (Symmetrical fault & Unsymmetrical fault) analysis.
4. Simulation of DC Distributor.

5. Study of power flow through transmission line.

6. Study of Underground cable.

7. Study of mechanical design of over head transmission.

8. Study of different type of insulator.

Text/References:

1. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
2. A. Hussain, Electrical Power System,CBS Publishers,2007

EEL1503 CONTROL SYSTEMS-I 3-0-0-6

1. Introduction: The control problem and its solution, feedback, regulation and tracking problems. LECTURES:3

2. Physical Systems and Models: Transfer function, examples with mechanical, electrical, hydraulic, pneumatic systems and systems with dead zone; control system components: error detectors, gears, gyroscope, dc motors, servomotors, techogenerators, servo amplifiers; block diagrams and reduction techniques, signal flow graphs, Mason's gain formula. LECTURES:12

3. Time Domain Analysis: Time domain analysis of 1st and 2^{nd} order systems; transient and steady state responses; transient and steady state responses with unity feedback system; sensitivity and error analysis. LECTURES:6

4. Root Locus Analysis: Root locus; effects of pole/zero on root locus; stability and relative stability using root locus. LECTURES:5

5. Frequency Domain Analysis: Routh array analysis; Bode, polar and Nyquist plots; stability and relative stability using these plots; M and N circles; Nichols plot. LECTURES:9

6. Controller/ Compensator Design: Design of lag, lead and lag – lead compensators; P, PD, PI and PID error control strategies. LECTURES:5

Readings:

Prescribed Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Control Systems Principles and Design, Tata McGrow Hill, 2012

Additional Readings

1. D' Azzo and Houpis, Linear Control Systems Analysis and Design McGrow Hill,

1995
2. N S Nise, Control Systems Engineering John Wiley & sons, 2011
3. R. C. Dorf and R. H. Bishop, Modern Control Systems, Addison Wesley, 1999

EEP1503 CONTROL SYSTEM-I LABORATORY 0-0-3-3

1. Use of MATLAB and SIMULINK for analysis and simulation of control system
2. Familiarization of Control Engineering Trainer, Modular Servo system, Process Trainer.
3. Study of pole-zero configuration, step response, stability analysis using Bode and Nyquist plots, study of gain and phase margins.
4. Design of compensators, controllers.
5. Study of open loop and closed loop frequency response and effect of addition of poles and zeros.
6. Study of relay control system.
7. Study of P, PI and PID controller of type 0 and type 1 system with time delay
8. Study of open loop response of (i) Error detector and (ii) Integrator.
9. Study of closed loop behaviour of first, second and third order systems.
10. Study of frequency response test of RLC circuit.
11. Study of time response of RLC circuit.
12. Study of Lead lag controller design.

Text/References:

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Control Systems Principles and Design, Tata McGrow Hill, 2012.

6TH SEMESTER

EEL1601 POWER SYSTEMS-II 3-1-0-8

1. Per Unit Representation of Power Systems
The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system. LECTURES:5

2. Fault Analysis: Causes of faults, types of faults, importance of fault analysis in electrical power systems, identification of system fault, fault analysis for generators, transmission lines, concepts of generator reactance's; transient, sub-transients etc, current limiting reactors, types, functions. LECTURES:10

3. Symmetrical Components and Unsymmetrical Fault Analysis: Concepts of symmetrical components, Fortescue's theorem, power in terms of symmetrical

components, sequence impedances and sequence networks for generators, transformers, transmission lines etc, unsymmetrical fault (L-G, L-L, LL-G) analysis.
LECTURES:6

4. Power System Stability: Review of operation of synchronous machine; infinite bus; stability- classification, power limit of transmission lines, steady state stability, Clarke's diagram, transient stability- the swing equations, equal area criterion, critical clearing angles; power angle curves for fault and post fault conditions for various types of faults; solution of swing equation, dynamic stability; factors affecting stability.
LECTURES:7

5. Load Flow Analysis: Static load flow equation, system, bus classification, Formation of admittance matrix. Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods and comparison of methods. LECTURES:6

6. Economic Operation of Energy Generation Systems: Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling; Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling. LECTURES:5

7. Automatic Generation Control: Introduction, frequency problems, load frequency control-single area & two are system, automatic voltage regulator (AVR), Speed governor system. LECTURES:6

Readings:

Prescribed Text Books

1. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
2. J.H. Grainger and W.D. Stevenson Jr., Power System analysis, McGraw-Hill, 1994

Additional Readings

Additional Readings:

1. D.P Kothari and I J Nagrath, Modern Power System, Tata McGraw-Hill, 2008
2. M.L. Soni, P.V. Gupta, U.S. Bhatnagar Electric Power, Dhanpat Rai & Sons, 1984
3. P.Kundur, Power system stability and control, McGraw-Hill, 1994

EEP1601 POWER SYSTEMS-II LABORATORY 0-0-3-3

1. Simulation of Symmetrical fault.
2. Simulation of Unsymmetrical fault.
3. Study of directional over current relay.
4. Study of differential relay.
5. Study of distance protection using distance relay
6. Study of Distribution transformer protection for differential & over current faults.

7. Newtons'-Raphson Load flow analysis of multi-bus power system network.
8. Economic load dispatch in power systems.
9. Study of AVR of DC shunt generator.

Text/References:

1. C.L. Wadhwa, Electrical Power systems, New Age International, 2007
2. J.H. Grainger and W.D. Stevenson Jr., Power System analysis, McGraw-Hill, 1994

EEL1602 CONTROL SYSTEM-II 3-0-0-6

1. Introduction to Discrete Time Systems: mathematical preliminaries- difference equations, Z Transform and properties; sampling quantization and reconstruction process,discrete time systems, system response, transfer function stability and the jury stability criterion, implementation of digital controllers and digital controllers for deadbeat performance. LECTURES:12

2. State Space Representation of Continuous Time and Discrete Time Systems: state space models, state space representation of simple electrical and mechanical systems, canonical forms, solution of state equation, state transition matrix, relation between transfer function and state variable representations; controllability and observability, pole- placement using state variable feedback; design of full order and reduced order observer, observer based state feedback controller. LECTURES:12

3. Introduction to Nonlinear Feedback Control Systems: characteristics of nonlinear systems; linearization techniques; phase plane analysis, singular points, limit cycle vs closed trajectory; stability analysis using phase plane analysis- describing function (DF) of common nonlinearities, stability analysis using DF; stability in the sense of Lyapunov, Lyapunov's stability theorems for linear and nonlinear systems; effect of non-linearity in root locus and Nyquist plot. LECTURES:15

Readings:

Prescribed Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003

Additional Readings

1. R. C. Dorf and R. H. Bishop, Modern Control Systems, Prentice Hall, 2010
2. B C. Kuo, Digital Control Systems, Oxford University Press, 1995
3. M. Gopal, Modern Control System Theory, New Age International, 1993

EEP1602 CONTROL SYSTEM-II LABORATORY 0-0-3-3

1. Design of load compensation and by compensation using MATLAB
2. Familiarization and use of MATLAB command associated with state variable analysis and Digital Control System.
3. Determination of phase plane trajectory and possibility of limit cycle of common n on-linearities.
4. Familiarisation with digital controller and determination of response due to variation of controller parameters.
5. Determination of response with common nonlinearity as introduced into the forward path of a 2nd order unity feedback control system using MATLAB.
6. Determination of response in Z- domain using MATLAB SIMULINK Toolbox or otherwise.
7. Study of sample and hold circuit.
8. Design and simulation study of state feed back control of DC motor.

Text/References:

1. K. Ogata, Modern Control Engineering, Pearson Education, 2009
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003

EEL1603 POWER ELECTRONICS 3-0-0-6

1. Introduction: Scope and applications. LECTURES

2. Power semiconductor Devices: Power diodes, power transistors, SCRs, TRIACs, GTOs ,power MOSFETs and IGBTs- principles of operation and V-I characteristics, device specifications , ratings, protection and cooling; methods for turning on SCRs, gate triggering circuit, methods for turning-off SCRs. LECTURES-8

3. AC to DC Converter: single and three phase diode rectifiers for various loads, single and three phase thyristor rectifiers for various loads, effect of source impedance; symmetrical and unsymmetrical semi converter and dual converter- effect on power factor and total harmonic distortion (THD). LECTURES-10

4. DC to DC Power Converters: limitations of linear power supplies, switched mode power supplies (buck, boost, buck-boost, cuk, fly-back and forward converters). LECTURES-4

5. DC to AC Converters: principle of operation of inverters, half bridge, full bridge, three phase- six step operations, voltage control- pulse width modulation (PWM) techniques. LECTURES-4

6. AC Controllers: Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads. Principle of operation of cycloconverters, circulating and non circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconveter. LECTURES:8

7. Applications: HVDC transmission. Static circuit breaker, UPS, static VAR controller LECTURES:3

Readings:

Prescribed Text Books

1. N. Mohan,T. Undeland, W. Robbins, Power Electronics Converter ,Applications And Design, John Wiley & Sons, 2003
2. G.K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House,2003

Additional Readings

1. S. B. Dewan &A. Straughen, Power Semiconductor Circuits, John Wiley & Sons, 2012

2.B.K Bose, Modern Power Electronics and AC Drives, Pearson Education, 2003

3.M. Rashid, Power Electronics, Prentice Hall India Ltd, 2004

EEP1603 POWER ELECTRONICS LABORATORY 0-0-3-3

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a Triac.
3. Study of different triggering circuits of an SCR.
4. Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge.
5. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
6. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
7. Study of performance of step down chopper with R and R-L load.
8. Study of performance of single phase controlled converter with and without source inductance (simulation).
9. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch(simulation).
10. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter (Simulation).
11. Study of performance of three phase controlled converter with R & R-L load. (simulation)
12. Study of performance of PWM bridge inverter using MOSFET as switch with R and

R-L load.

13. Study of performance of three phase AC controller with R and R-L load (simulation)
14. Study of performance of a Dual converter. (simulation)
15. Study of performance of a Cycloconverter (simulation)

Text/References:

1. N. Mohan,T. Undeland, W. Robbins, Power Electronics Converter ,Applications And Design, John Wiley & Sons, 2003

2. G.K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House,2003

7TH SEMESTER

EEL1701 ELECTRICAL DRIVES 3-0-0-6

1. Fundamentals of Electric Drives: Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability, Multiquadrant operation of drives,Load equalization. LECTURES:8

2. Motor Power Rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads, Effect of load inertia & environmental factors. LECTURES:6

3. DC Motor Drives: Modelling of DC motors, State space modeling, block diagram & Transfer function, , Starting and braking of DC motor, Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting and braking. Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives, closed loop control of DC motor LECTURES:10

4. Induction Motor Drives: Performance of induction Motor, Starting and braking of induction motor, Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control. LECTURES:10

5. Synchronous Motor Drives: Performance of synchronous motor drive, Starting and braking of synchronous motor drive, Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive, Vector control, Permanent magnet motor, Stepper motor, Switched Reluctance motor drive. LECTURES:8

Readings:

Prescribed Text Books

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, Tata Mcgraw Hill.
3. A first course on Electrical Drives, S.K. Pillai, New Age International Publication.

Additional Readings

1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

EEP1701 ELECTRICAL DRIVES LABOTORY 0-0-3-3

1. Study of Thysistor controlled DC Drive.
2. Study of Chopper fed DC Drive.
3 Simulation of Thysistor controlled DC Drive using PSIM/MATLAB.
4. Simulation of Chopper fed DC Drive using PSIM/MATLAB.
5. Study of AC Single phase motor-speed control using TRIAC.
6. PWM Inverter fed 3 phase Induction Motor control using PSPICE / MATLAB / PSIM Software.
7. VSI / CSI fed Induction motor Drive analysis using MATLAB/DSPICE/PSIM Software.
8. Study of V/f control operation of 3Φ induction motor drive.
9. Study of permanent magnet synchronous motor drive fed by PWM Inverter using Software.
10. PC/PLC based AC/DC motor control operation.

Text/References:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH

EEL1702 SWITCHGEAR AND PROTECTION 3-0-0-6

1. Circuit Breakers (CBs): Function, arc phenomenon and arc interruption theories, CB types (min. oil, vacuum and SF_6), circuit breaking transients, restriking and recovery voltages, CB ratings, testing of CBs; introduction to solid state CBs

LECTURES-5

2. Protective Relays: Operating principles, classification, electromagnetic type relays theories for torque generation, protective zones, over current relay-characteristics, directional relay-torque generation, feeder protection- time grading and current grading, distance relays and their characteristics, differential protections, protection of transmission lines, generator and transformers, transley relay, negative sequence relay. LECTURES-20

3. Fuses: Principal, operation, types and application. LECTURES-3

4. Substation Layouts For Protection: Single line diagram with different busbar arrangement, reactors, isolators, bus-tie breakers, substation grounding, surge protection. LECTURES-5

5. Neutral Grounding: Principals of neutral grounding, ungrounded system-arcing ground, types of grounding- solid, resistance, reactance and resonant grounding, generator neutral breaker, grounding practices. LECTURES-5

6. Lightning Arrester: Function, types, working principles and surge absorbers.

LECTURES-2

Readings:

Prescribed Text Books

1. S. S Rao, Switchgear and Protection, Khanna Publisher, 1999
2. D.N Vishwakarma, Badri Ram, Power System Protection and Switchgear, Tata McGraw - Hill Education 2011

Additional Readings

1. J B Gupta, Switchgear and Protection, S.K. Kataria & Sons, 2002
2. A. Wright and C. Christopoulos, Electrical Power system protection, Chapman & Hall, 1993.

EEL1703 INSTRUMENTATION 3-0-0-6

1. Introduction: functional description of instrumentation system- transducers, signal conditioners, filters, amplifiers, DA/ADC, 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, display devices, instrumentation amplifiers and circuits. LECTURES-6

2. Transducers and Sensors: classification and selection of transducers/ sensors; resistive, capacitive, inductive, piezoelectric, photoelectric transducers and their applications. LECTURES-3

3**. Measurement of Displacement:** Theory and construction of various transducers to measure displacement – Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers. LECTURES-3

4. **Measurement of Level:** Methods of liquid level measurement, sight glass, pressure gauge method, capacitance level indicator, Radiation level detector, laser level sensor, optical level detector, ultrasonic level sensor. LECTURES-3

5**. Measurement of Temperature:** Classification – Ranges – Various Principles of measurement– Expansion, Electrical Resistance – Thermistor – Thermocouple – Pyrometers – Temperature Indicators. LECTURES-3

6. **Measurement of Pressure:** Units – classification – different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges – ionization pressure gauges, Mcleod pressure gauge. LECTURES-3

7**. Measurement of Fluid Flow:** Flow characteristics obstruction meters, Obstruction meter for compressible fluids, the variable-area meter, calibration of flow measurement devices. LECTURES-3

8. Advance Topics in Instrumentation:

(a) Digital data acquisition systems
(b) Smart sensors – introduction, principle of working, information coding, data communication & automation.
(c) Intelligent Instrumentation- main concepts, practical examples.
(d) Instrumentation for remote control system: introduction, general descriptions, typical scheme of an industrial remote control system.
(e) Telemetry. LECTURES-9

Readings:

Prescribed Text Books

1. E.O. Doeblin, Measurement Systems, McGraw Hill,2004
2. S.K.Singh, Industrial Instrumentation and Control

Additional Readings

1. C.S Rangan, G.R. Sarma& VSV Mani, Instrumentation, Devices & system, Tata

McGraw Hill, 2002
2. D.V.S Murthy, Transducers & Instrumentation, PHI, 2004

EEP1703 INSTRUMENTATION LABORATORY 0-0-3-3

1. Measurement of resistance with a Wheatstone bridge, Study of conditions for the greatest sensitivity, operation with alternating current source, amplifier and transducer.
2. Study of characteristics of various types of transducers and calibration.
3. Use of various sensors (temperature, level, liquid flow, air flow, pressure Gauge) in loops comprising PID controller, PLC & DCS and their modeling.
4. Development of PC based instrumentation.
5. Study of sensors characteristics using LabView.
6. Control with PCs of the above five (Sl-2) process loops in LabView platform.
7. Measurement of flow, level using different sensors for different pipe diameters and liquid temperatures
8. Comparative study of temperature measurement using: RTD, Thermistor and Thermocouple.

Text/References:

1. E.O. Doeblin, Measurement Systems, McGraw Hill, 2004
2. S.K.Singh, Industrial Instrumentation and Control

EEL1704 POWER PLANT ENGINEERING 3-0-0-6

1. Conventional Sources of Electrical Energy: steam, hydro, nuclear, diesel and gas; their scope and potentialities for energy conversion; generation – different factors connected with a generating station; load curve, load duration curve, energy load curve; base load and peak load plants. LECTURES-8

2. **Thermal Stations**: selection of site, size and no. of units, general layout, major parts, auxiliaries, generation costs of steam stations**.** LECTURES-8

3. Hydro Stations: selection of site, mass curve, flow duration curve, hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants. LECTURES-4

4. Nuclear Stations: main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal. LECTURES-7

5. Governor & Exciter: – excitation systems, excitation control, automatic voltage regulator action, different types of Governor**.**

LECTURES-6

6. Alternate Energy Sources – solar, wind, geo-thermal, ocean-thermal, tidal wave MHD and biomass**.** LECTURES-8

Readings:

Prescribed Text Books

1**.** B.R.Gupta, Generation of Electrical Energy S. Chand limited, 2009
2**.** P.Kundur, Power system stability and control McGraw-Hill, 1994

Additional Readings

1. M.V. Deshpande, Elements of Electrical Power Station Design, WheelerPublishing Co., 1979
2**.** Soni, Gupta, Bhatnagar Electric Power Dhanpat Rai & Sons, 1984
3**.** J.B.Gupta A course in Power Systems S.Kataria & SONS, 2002

8TH SEMESTER

EEL1802 ELECTRICAL ENERGY UTILISATION AND AUDIT 3-0-0-6

1. Electric Traction: D.C. and A.C traction, electric traction motors- starting, speed control and braking; system of power supply in traction. LECTURES-5

2. Electric Heating: Classification, methods of electric heating, resistance, dielectric, induction and arc heating, high frequency heating, comparison of electric heating methods, Applications. LECTURES-4

3. Electric Welding: Classification, methods of welding, resistance, electric arc, ultrasonic and laser weldings; welding-transformer, power sources and control circuits, control of current flow. LECTURES-6

4. Illumination: introduction, nature of radiation, definitions, polar curves, laws of illumination, luminous efficiency, sources of light, incandescent, vapour, compact florescent lamp, LED and florescent lighting; factory lighting, flood lighting, street lighting and residential lighting. LECTURES-10

5. Energy Audit: necessity of energy audit,types of energy audit- preliminary and detailed energy audit, energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, energy audit methods of saving electricity in drives, lighting, and distributions systems metering, case study of energy auditing and potential energy saving. LECTURES-15

Readings:

Prescribed Text Books

1. Albert, Plant Engineers & Managers Guide to Energy Conservation, the Fairmont Press, 2011
2. C. Wayne, Turner Energy management handbook, John Wiley and Sons, 1982
3. H. Partab, Art and Science of Electrical Energy, Dhanpat Rai and Co. Pvt. Ltd, 1994
4. H. Partab, Modern Electric Traction, Dhanpat Rai and Co. Pvt. Ltd, 1998

Additional Readings

1. NPC energy audit manual and reports
2. Barney L. Capehart, Wayne C. Turner, William J. Kennedy Guide to Energy Management, 2008

ELECTIVES

SUBJECT: HIGH VOLTAGE ENGINEERING 3-0-0-6

1. 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. LECTURES-11

2. 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. LECTURES-6

3. 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. LECTURES-6

4. Insulation materials and systems: Insulation systems in practice, dielectric losses, ageing and life expectancy. LECTURES-4

5. Outdoor insulation: Materials, ageing, diagnostic, polymeric materials (EPDM, SIR), semi conducting ceramic glazes. LECTURES-3

6. 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. LECTURES-4

7. Breakdown in liquid dielectrics-suspended particle mechanism. LECTURES-3

8. Breakdown in solid dielectrics-intrinsic, streamer, thermal breakdown. LECTURES-3

Readings:

Prescribed Text Books

1. C.L. Wadhwa , High Voltage Engineering, New Age publication, 2007

Additional Readings

1. D. Kind and K. Feser, High Voltage Test Technique, SBA Publication, 1999
2. M.S. Naidu & V. Kamaraju, High Voltage Engineering, McGraw Hill, 1995

SUBJECT: COMPUTER AIDED POWER SYSTEMS ANALYSIS 3-0-0-6

1. Algorithm for formulation of bus, types of modifications, short-circuit studies: single line to ground fault, line-to-line fault, double line to ground fault and symmetrical fault, consideration of pre-fault currents. LECTURES-8

2. Algorithm and flow-chart for computer application to load flow studies, using G-S method, Newton-Raphson method and fast Decoupled load flow methods. LECTURES-8

3. Algorithm and flow-chart for computer application to economic load dispatch: neglecting losses, including losses, optimum generation schedule of hydro-thermal system. LECTURES-8

4. Aims and functions of control centers, set up, locations, central facilities, civil facilities, facilities in control room, communication, telemetry, emergency control. LECTURES-6

5. Power System Management: load dispatch center, reporting and data management, load dispatcher in the consumer setup, load control center, computerized power system control, SCADA systems and RTU. LECTURES-6

Readings:

Prescribed Text Books

1. A. Chakrabarti & S. Halder, Power System Analysis Operation & Control, PHI, 2006
2. H. Saadat, Power System Analysis, TMH, 2002
3. R. P. Singh, Digital Power System Protection, PHI, 2007

Additional Readings

1. G. W. Stagg and A. H. El-Abiad, Computer methods in power system, MGH, 1965
2. I. J. Nagrath & D. P. Kothari , Power System Engineering, TMH, 1994

SUBJECT: ADVANCED POWER ELECTRONICS 3-0-0-6

1. Phase Controlled Converters: Performance measures of single and three-phase converters withdiscontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters. LECTURES-7

2. Chopper: Review of choppers configurations, Steady state analysis of type A Chopper, Minimum and Maximum Currents, Ripple and average load current, Commutation in Chopper Circuits. LECTURES-7

3. Inverters: Performance parameters, voltage control of three phase inverters-Sinusoidal PWM, Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions. LECTURES-8

4. AC Voltage Controllers: Single and Three Phase AC Controllers. AC Voltage Controller with PWM Control. LECTURES-6

5. Cyclo-Converters: Single phase and three phase Cyclo-converters, Reduction in Output Harmonics, Matrix Converter. LECTURES-6

Readings:

Prescribed Text Books

1. N. Mohan, Undeland and Robbin, Power Electronics: converters, Application and design, John Wiley and sons, 2003
2. P.S. Bhimra, Power Electronics,Khanna Publishers, 1998

Additional Readings

1. B.K. Bose, Modern Power Electronics & AC drives, Prentice Hall,200
2. Robert W. Ericson, Fundamentals of Power Electronics, Chapman & Hall, 2001

SUBJECT: FLEXIBLE AC TRANSMISSION SYSTEM 3-0-0-6

1. Introduction of Semiconductor Devices: Steady state and dynamic problems in AC systems, power flow. LECTURES-6

2. **Flexible AC Transmission Systems (FACTS**): Basic realities & roles, types of FACTS controller, principles of series and shunt compensation. LECTURES-7

3. Description of Static Var Compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static condenser (STATCON), static synchronous series compensator (SSSC) and unified power flow controller (UPFC). LECTURES-7

4. Modelling and Analysis of FACTS Controllers; control strategies to improve system stability; power quality problems in distribution systems. LECTURES-8

5. Harmonics, Harmonics Creating Loads, Modelling, series and parallel resonances, harmonic power flow, mitigation of harmonics, filters, passive filters; active filters shunt, series hybrid filters, voltage sags and swells, voltage flicker; mitigation of power quality problems using power electronic conditioners. LECTURES-12

Readings:

Prescribed Text Books

1. N.G. Hingorani, Understanding of FACTs, Wiley-IEEE press, 1999
2. G.T. Heydt, Power Quality, Stars in Circle Publications, 1991.
3. T.J.E. Miller, Static Reactive Power Compensation, John Wiley & Sons, 1982.

Additional Readings

1. Yong Hua Song, Flexible AC transmission system (FACTS), 1999
2. Recent publications on IEEE Journals.

SUBJECT: DIGITAL CONTROL SYSTEMS 3-0-0-6

1. Sampling and reconstruction: Sampled data control system, Digital to analog conversion, analog to digital conversion, sample and hold operation. LECTURES-8

2. Transform analysis of sampled data system: Linear differential equation, solution of linear difference equations , pulse response z transform, the pulse transform function, block diagram analysis of sampled data system, stability analysis. LECTURES-11

3. Application of z transform to open loop system, application of z transform to closed loop system, stability of sampled data feed back system. LECTURES-11

4. **State space analysis of sampled data system**: Discrete time state equation, simplicity transformation, the Caylex – Hamilton theorem, realization of pulse transfer function, State equation for sampled data system. LECTURES-10

Readings:

Prescribed Text Books

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003

Additional Readings

1. D.K. Cheng, Linear System Analysis, Narosa Publishing House. 1995

SUBJECT: HIGH VOLTAGE DC 3-0-0-6

1. Development of HVDC technology, DC versus AC Transmission, selection of converter configuration. LECTURES-4

2. Rectifier and Inverter Operation, digital simulation of converters, control of HVDC converters and systems, individual phase control, equidistant firing controls, higher level controls; characteristics and non-characteristics harmonics filter design. LECTURES-10

3. Fault Development And Protection; interaction between AC-DC power systems. LECTURES-5

4. Over Voltages On AC/DC side, multi-terminal(MT) HVDC systems, control of MT DC systems. LECTURES-10

5. Modelling of HVDC Systems, per unit system; representation for power flow solution; representation for stability studies. LECTURES-10

Readings:

Prescribed Text Books

1. K. R. Padiyar, HVDC Power Transmission Systems, Wiley Eastern Ltd, 1990.

Additional Readings

1. J. Arrillag, High Voltage Direct Transmission, Peter Peregrinus, 1983.
2. E. W. Kimbark, Direct Current Transmission, Vol.I, Wiley Interscience, 1971.
3. Erich Uhlmann, Power Transmission by Direct Current, B.S. Publications, 2004.

SUBJECT: ILLUMINATION ENGINEERING 3-0-0-6

1. Introduction Of Illumination And Radiation:- Introduction, Wavelength, frequency & velocity, radiation spectrum, Radiations from black bodies & other sources. LECTURES-3

2. Entities In The Illumination System And Their Units:- Luminous sources, illumination, intensity, luminance, other terms and units, The inverse square law, The cosine law, Solid angle relationship, luminous energy, luminous flux spectral power distribution, illumination standards. LECTURES-3

3. The Eye & Vision:- The structure of the eye, accommodation, aberration of the eye, the rods & cones, glare, color vision, visual acuity. LECTURES-3

4. Light Sources & Their Characteristics:- Incandescent lamp, electric gas discharge phenomena,discharge lamp, fluorescent lamp, Compact Fluorescent Lamps (CFL),SOX,SOM,MH,Neon, LED lights and LASERS, Starters & ballast. LECTURES-15

5. Light Control:- Reflection & reflection factor, refraction,absorption, transmission & transmission factor,polarization,polarization by reflection,Control of light by luminaries. LECTURES-2

6. Light and its measurement:- Average luminous intensity determination, Zonal lument, polar curve,Radiant energy detectors, PV cell, Photo coluxmeters, gonio photo meters,integrating sphere, Spectro-photometer, Colorimeters. LECTURES-11

7. Lighting Design:- Illumination from-point,linear,area sources, Average illuminance, calculation for interior,zonal cavity method,specifying the quality of illuminance,glare,road lighting,Flood lighting LECTURES-6

Text Books:

1. Hems and Belcher,Lighting for energy efficient luminous environment,Prentice Hall.
2. O.N.Awasthi,Fundamental of Lighting, Narosa publication.
3. Anil Valia,Designing with Light,International lighting Academy.

Reference Books:

1. Cotton.H, Principles of Illumination, Chapman & Hall, 1960.
2. IES Lighting Handbook, Illumination Engineering Society, New York.
3. Lindsey,Applied illumination Engineering, the Fair mount press.

SUBJECT: SMART GRID 3-0-0-6

1. Overview of Conventional Grid Power system: Basic components of power system, power generation scenarios, Conventional and restructured power system, function of energy control centres, short comings of exciting power grids-emissions, blackouts, emergence of the concepts of smart grid. LECTURES-6

2. Renewable Generation : Renewable Resources: Wind and Solar, Micro-grid Architecture, Distributed Storage and Reserves, Dealing with short term variations, stochastic models based on price forecasting. LECTURES-6

3. Power System Economics: Power system generation economics, Modeling of Consumers and producers, Electricity market structures, Marginal price, Optimal Power Flows, Distribution systems basics under new environment etc. LECTURES-6

4. Smart Grid: Definition, Various components, Application and standards, Impacts of Smart Grid on reliability, Impacts of Smart Grid on air pollutant emissions reduction. LECTURES-6

5. Smart Grid Communications: Two-way Digital Communications Paradigm, Network Architectures, IP-based Systems Power Line Communications, Advanced Metering Infrastructure. LECTURES-5

6. Demand Side Management: Definition, Applications, Load characteristics, load curve and load duration curve, Energy Consumption Scheduling, Controllable Load Models, Dynamics, and Challenges, Plug-in-hybrid Vehicles and smart appliances. LECTURES-5

7. Wide Area Measurement: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Applications and Challenges. LECTURES-3

8. Security and Privacy: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defense Mechanisms, Privacy Challenges. LECTURES-3

Reference Books:

1. D.S. Kirshen, Fundamentals of Power System Economics, John Wiley & Sons.
2. A. J. Wood, B. F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons
3. G. M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons.
4. S. Stoft, Power System Economics: Designing Markets for Electricity, Wiley-Interscience.

SUBJECT: ELECTRICAL MACHINE DESIGN 3-0-0-6

1. Introduction: Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations - Heat flow – Temperature rise - Rating of machines – Standard specifications. LECTURES-5

2. DC machines : Output Equations – Main Dimensions - Magnetic circuit calculations – Carter's Coefficient - Net length of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values. LECTURES-10

3. Transformers : Output Equations – Main Dimensions - KVA output for single and three phase transformers – Window space factor – Overall dimensions – Operating characteristics – Regulation – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers. LECTURES-10

4. Induction motors: Output equation of Induction motor – Main dimensions – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor -– Magnetic leakage calculations – Leakage reactance of polyphase machines- Magnetizing current - Short circuit current – Circle diagram - Operating characteristics. LECTURES-10

5. Synchronous machines: Output equations – choice of loadings – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design. LECTURES-5

Textbooks:

1. Sawhney, A.K., A Course in Electrical Machine Design, Dhanpat Rai & Sons, New Delhi,1984.
2. Sen, S.K., Principles of Electrical Machine Designs with Computer Programmes, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

References

1. A.Shanmugasundaram, G.Gangadharan, R.Palani, Electrical Machine Design Data Book, New Age Intenational Pvt. Ltd., Reprint 2007.

SUBJECT: NON-CONVENTIONAL ENERGY SOURCE 3-0-0-6

1. **Non-conventional Sources of Electrical Energy**- Solar, wind, geo-thermal, ocean, tidal, wave, magnetohydrodynamic (MHD) and biomass; their scope and potentialities for energy conversion. LECTURES-6

2. **Solar Energy**- Introduction, physical principles of conversion of solar radiation into heat, solar energy collectors, solar energy storage, solar-electrical power generation and other miscellaneous applications of solar energy. LECTURES-8

3. **Wind Energy** – Introduction, basic principle of wind energy conversion, wind data and energy estimation, site selection, basic component of wind energy conversion system, wind turbines and their analysis, wind-electrical generation; stand-alone and grid connected wind-electrical power system, various applications of wind energy. LECTURES-10

4. Modelling and control of wind and solar energy systems. LECTURES-6

5**. Optimisation Technique**-Wind / solar photovoltaic integrated systems design, grid synchronized inverter system. LECTURES-8

Readings:

Prescribed Text Books

1. S. Rao and B.B. Parulekar, Energy Technology, Khanna Publishers, 2002.
2. G.D Rai, Non-conventional Energy Sources, Khanna Publishers, 2002.
3. S.P. Sukhatme, Solar Energy, Tata McGrawhill Publishing Co. Ltd., 2003

Additional Readings

1. Thomas Ackermann, Wind Power in Power System, John Willey &Sons, 2005.
2. Rai G.D., Non - Conventional Energy Sources, Khanna Publishers, 1993.
3. Rai G.D., Solar Energy Utilisation, Khanna Publishers, 1993.

SUBJECT: NEURAL NETWORKS 3-0-0-6

1. Introduction: neurons and neural networks, basic models of artificial neural networks learning process: error correction learning, hebbian learning, competitive learning, Boltzman learning, the credit assignment problem, supervised learning, reinforce learning, unsupervised learning, statistical nature of the learning process. LECTURES-8

2. Multilayer Perceptron: back propagation algorithm, the x-or problem, accelerated convergence of back propagation through learning rate adaptation, supervised learning viewed as a nonlinear identification and function optimization problem. LECTURES-8

3. Radial Basis Function (RBF) Network: Cover's theorem on the separability of patterns, interpolation problem, generalized radial basis function. LECTURES-7

4. Recurrent Networks: learning strategies, the Hopfield network, error performance of Hopfield network, isomorphism between Hopfield network and a spin-glass model. LECTURES-7

5. Self-Organizing Systems: Hebbian learning: principles of self organization, self organized feature analysis, principal component analysis, adaptive principal component analysis using lateral inhibition**.** LECTURES-10

Readings:

Prescribed Text Books

1. S. Haykin, Neural Networks: A Comprehensive Foundation, Pearson, 2006.
2. S. Kumar, A Classroom Approach, TMH, 2004

Additional Readings

1. J. S. Roger Jang , C. T. Sun and E. Mizutani, A Computational Approach to Learning and Machine intelligence, Neuro-Fuzzy and Soft Computing, Prentice Hall, Digitized Nov, 2007.

SUBJECT: OPTIMISATION TECHNIQUES 3-0-0-6

Unconstrained And Constrained Minimization of Functions. Lagrange Multiplier Method, Linear Programming, Simplex Method, Duality Dynamic Programming, Principles Of Optimality.
Application to Control and Management Problems, Miscellaneous Topics, Sequencing, Scheduling and Inventory Control.

Text Books:

1. B. Rao, Optimization Techniques, Scitech, 2007
2. R. Panneerselvam, Operation research, PHI, 2011

References:

1. S.S Rao, Optimisation Theory and Applications, Wiley Eastern Ltd., 1984
2. S.S Rao, Engineering Optimization,New Age Int. (P) Ltd, 2000
3. B.S Gottfried and J. Weisman, Introduction to Optimization Theory, Prentice Hall, 1986