NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SYLLABUS FOR 2013 ONWARDS BATCH OF B.TECH PROGRAMME

3RD SEMESTER

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

1. Signals: classification of signals; signal operations: scaling, shifting and inversion; signal properties: symmetry, periodicity and absolute integrability, elementary signals.

2. Systems: 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.

3. Signal representation: signal space and orthogonal bases; Fourier series representation of continuous-time and discrete-time signals; continuous-time Fourier transform and its properties; Parseval's relation, time-bandwidth product; discrete-time Fourier transform and its properties; relations among various Fourier representations; Sampling- sampling theorem; aliasing; signal reconstruction: ideal interpolator, zero-order hold, first-order hold; Discrete-time Fourier transform (DTFT): Properties of DTFT, Application- frequency response of LTI systems.

4. Laplace transform and Z-transform: definition, region of convergence, properties; transform-domain analysis of LTI/LSI systems, system function: poles and zeros; stability.

5. Review of network theorems: Superposition, Thevenin’s, Norton’s, reciprocity, maximum power transfer, Millman’s and compensation theorems; **Network topology**: definition of basic terms, incidence matrix, tie-sets, cut-sets; **Two port networks**: characterization in terms of impedance, admittance, transmission, hybrid parameters and their relationships, interconnection of two port networks; **Symmetrical two port network**: T and π equivalents, image impedance, characteristic impedance and propagation constant.

Texts books:

1. M. J. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill, 2007.
2. M. E. Van Valkenburg, “Network Analysis”, 3/e, Prentice Hall of India, 2003.

References:

1. A.V. Oppenheim, A.S. Willsky and H.S. Nawab, Signals and Systems, Prentice Hall of India, 2006.
2. B. P. Lathi,Signal Processing and Linear Systems, Oxford University Press, 1998.
3. Simon Haykin, Barry van Veen, Signals and Systems, John Wiley and Sons, 1998.
4. C. A. Desoer and E. S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969.
5. F. F. Kuo, Netwok Analysis and Synthesis, Weily India, 2007.
6. K. S. Suresh Kumar, Electric Circuits and Networks, Pearson Education, 2009.

4TH SEMESTER

EEL1401 ELECTRICAL MACHINES-I 3-0-0-6

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.

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.

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

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.

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.

Texts books:

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

References:

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.

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 and their applications advantages and disadvantages.

2. Galvanometers and dynamics: dynamic behaviour of galvanometer - equation of motion for different damping conditions; response of galvanometer, operational constants, CDRX, relative damping, logarithmic decrement, sensibility; ballistic galvanometer and flux meter construction and theory of operation.

3. 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.

4. Potentiometers: standardization, principle of working and construction of Crompton, polar and co-ordinate type potentiometers.

5. 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.

6. 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; sensor based instruments. measurement of power at radio frequency(RF).

7. 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**.**

8. 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.

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.

References:

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.
5. B. G. Liptak, Instrument Engineers' Handbook: Process Measurement and Analysis, CRC, 2003.

5TH SEMESTER

EEL1501 POWER SYSTEMS-I 3-0-0-6

1. Introduction of generation: generation of electrical energy, sources of energy, comparison of different sources of power; basic idea about different power plants: thermal, hydro, diesel, nuclear.

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.

3. Transmission systems: introduction to transmission system (TS); transmission voltages; classification of TS, advantages of high voltage transmission; comparison of overhead and underground supply system; comparison of AC and DC transmission system; introduction to high voltage DC transmission (HVDC) and flexible AC transmission system (FACTS); comparison of conductor materials of various overhead systems; economic choice of conductor size, Kelvin's law.

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.

5. Line constants: introduction to overhead line (OHL) constants; copper cross section, conductor materials; resistance: resistance of OHL, calculations of resistance; 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; 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.

6. Mechanical design: introduction to mechanical design; towers: classification; design; 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, induction interference between power and communication lines.

7. 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.

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 and company, 2009

Reference Books

1. M.L Soni, 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

EEL 1502 CONTROL SYSTEMS - I **3-0-0-6**

1. Introduction: the control problem and its solution, feedback, regulation and tracking problems.

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.

3. Time domain analysis: time domain analysis of 1st and 2nd order systems; transient and steady state responses; transient and steady state responses with unity feedback system; sensitivity and error analysis.

4. Root locus analysis: Root locus; effects of pole/zero on root locus; stability and relative stability using root locus.

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.

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

Text books:

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

Reference Books:

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

EEL 1503 ELECTRICAL MACHINES -II **3-1-0-8**

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.

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.

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.

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.

5. Single phase Induction Motors: construction, analysis of starting and running characteristics; starting methods.

6. Linear Induction Motors: introduction, operating principles and application areas.

7. Stepper Motor: construction, torque-stepping rate characteristics, application areas.

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.

References:

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

EEP 1503 ELECTRICAL MACHINES LABORATORY 0-0-4-4

1. Open circuit and short circuit tests of single phase transformer.
2. Three phase transformer connections.
3. Open circuit test and load characteristics of DC generator.
4. Speed control and output characteristics of DC motor.
5. No load, blocked rotor and load tests on induction motor.
6. Open circuit and short circuit tests of an alternator.

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.

6TH SEMESTER

EEL 1601 POWER SYSTEMS-II 3-0-0-6

1. Performance of overhead transmission lines: introduction; classification of transmission lines; performance of short and medium transmission lines, nominal T and nominal π methods; performance of long transmission lines; power circle diagrams (PCD): receiving end, sending end, universal PCD, calculation of SPM Capacity, maximum power limit, percentage regulation, sending end power factor, efficiency of transmission line from PCD. loss and loss diagram.

2. Symmetrical fault analysis: causes of faults, types of faults, importance of fault analysis in electrical power systems, fault analysis for generators, transmission lines, concepts of generator reactance's; transient, sub-transients etc, current limiting reactors, types, functions.

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.

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.

5. Load flow analysis: static load flow equation, system, bus classification, Gauss Seidel, Newton-Raphson and fast-decoupled load flow methods and comparison of methods.

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

References:
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

EEL 1602 CONTROL SYSTEMS-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.

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.

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.

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

References:
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

EEL 1603 ELECTROMAGNETICS 3-1-0-8

1. Static fields: Coulomb's and Gauss' laws for electrostatics; Poisson's and Laplace's equations, method of images and boundary value problems, equation of continuity, Kirchoff's voltage and current laws, boundary conditions for current density; Biot-Savart's law, Gauss's and Ampere's laws for magnetostatics, magnetic vector potential; magnetic dipoles, magnetization, behavior of magnetic materials.

2. Maxwell's equations: Faraday's law of electromagnetic induction, Maxwell's equations and boundary conditions, time-harmonic fields.

3. Wave equation and plane waves: Helmholtz wave equation, solution to wave equations and plane waves; wave polarization, Poynting vector and power flow in electromagnetic fields.

4. Plane waves at a media interface: plane wave in different media, phase and group velocity, plane wave reflection from a media interface.

5. Antennas and radiating systems: radiation fundamentals, antenna patterns and parameters, Hertz dipole, wire antennas, loop antennas, antenna arrays; method of moments; introductory example from electrostatics, basic steps of the method of moments, linear operator equation, applications.

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

References:

1. A. Elsherbeni and V. Demir, The Finite-difference time-domain method for Electromagnetics with MATLAB Simulations, Scitech, 2009.
2. K. E. Lonngren and S. V. Savov, Fundamentals Electromagnetics with MATLAB, PHI, 2005.
3. C. A. Balanis, Antenna Theory: Analysis and Design, John Wiley, 2005.
4. R. K. Shevgaonkar, Electromagnetic Waves; McGraw Hill, 2006.
5. R. F. Harrington, Time-Harmonic Electromagnetic Fields, Wiley-IEEE, 2001.
6. N. Ida, Engineering Electromagnetics, Springer, 2000.

EEL 1604 POWER ELECTRONICS AND DRIVES 3-0-0-6

1. Introduction: Scope and applications

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.

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).

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)

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.

6. AC to AC converter: single phase step-up and step-down cycloconverters - mid-point, bridge-type topology; single, three phase half-wave cycloconverters.

7. Electric drives: introduction and classification; DC motor drives- speed-torque characteristic of shunt, series; permanent magnet DC motors- dynamic models, speed and position control methods; AC motor drives**:** d-q model of induction motors, constant flux speed control structure, vector control model and structure.

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

Reference Books:

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

EEP1604 POWER ELECTRONICS AND DRIVES LAB 0-0-3-3

List of Experiments

1. Study of terminal characteristics of SCRs, TRIACs, MOSFETs and IGBTs

2. Study of triggering circuits for SCR: resistance gate triggering; resistance- capacitance gate triggering; UJT triggering circuits

3. Study of single-phase controlled rectifiers: half-wave controlled, fully-controlled and half-controlled rectifires.

4. Study of class-A type voltage commutated DC chopper

5. Study of single-phase AC voltage-controller using (i) anti-parallel SCRs and (ii) TRIACs

6. Study of single-phase cycloconverter with R and RL loads

7. Study of AC/DC motor control by power electronic converters

References:

1. P.S.Bhimbra, Power Electronics, Khanna Publishers, 2005

EEP 1502 CONTROL SYSTEM LAB 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. Design of observer using pole placement
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 relay control system
10. Study of DC position and speed control, potentiometric error detector
11. Study of AC position control, synchro transmitter/receiver, compensation design
1**2.** Study of closed loop behaviour of first, second and third order systems
13. Familiarization with Lab View and ELVIS-II+

References:

1. R.H. Bishop, Modern Control Systems Analysis and Design in MATLAB and SIMULINK Addition, Wesley, 1993

7TH SEMESTER

EEL 1701 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

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.

3. Fuses: principal, operation, types and application.

3. Substation layouts for protection: single line diagram with different busbar arrangement, reactors, isolators, bus-tie breakers; substation grounding; surge protection.

4. Neutral grounding: principals of neutral grounding, ungrounded system-arcing ground; types of grounding- solid, resistance, reactance and resonant grounding; generator neutral breaker; grounding practices.

5. Lightning arrester: function, types, working principles and surge absorbers.

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

References:

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.

EEL 1702 INSTRUMENTATION 3-0-0-6

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

2. Transducers and sensors: classification and selection of transducers/ sensors; resistive, capacitive, inductive, piezoelectric transducers and their applications; thermistors; magnetostrictive, Hall Effects and electromagnetic transducers; photoelectric transducers.

3. Analytical instrumentation: measurements of pressure, flow, temperature and liquid level.

4. Non destructive testing: testing methods using magnetic particles, dye penetrants, X rays, Gamma rays; eddy current testing; ultrasonic testing**-** principle of working; pulse echo method of flaw detection.

5. Data transmission and telemetry: basic telemetering system-voltage, current & frequency telemetering; multiplexing and modulation in telemetry; PLCC; transmitters and receivers.

6. Fiber optical instrumentation: principle of working**;** optical fiber cable**-** dispersion and losses**;** connectors and splices, sources and detectors; transmitters and receiver circuits.

7. 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) Internet based tele-metering.

Text books:

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2012
2. E.O. Doeblin, Measurement Systems, McGraw Hill, 2004

References:

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

EEL 1702 INSTRUMENTATION LAB 0-0-3-3

List of experiments

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.

References:

1. A.K.Sawhney, A course in Electrical and Electronic Measurments and Instrumentation, Dhanpat Rai Publications,2012

8TH SEMESTER

EEL 1802 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.

2. Electric heating: methods of electric heating, resistance, dielectric, induction and arc heating.

3. Electric welding: methods of welding, resistance, electric arc, ultrasonic and laser weldings; welding transformer-control of current flow.

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.

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.

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

References:

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

LIST OF ELECTIVE SUBJECTS

EEL XXX POWER STATION PRACTICE 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.

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

3. Hydro stations; selection of site, mass curve, flow duration curve, hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants.

4. Nuclear stations; main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal.

5. Power station control and interconnection – excitation systems, excitation control, automatic voltage regulator action; advantage of interconnection**.**

6. Alternate energy sources – solar, wind, geo-thermal, ocean-thermal, tidal wave MHD and biomass.

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

References:

1. M.V. Deshpande, Elements of Electrical Power Station Design, Wheeler Publishing 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

EEL 1XXX 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

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

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

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

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

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

7. Breakdown in liquid dielectrics-suspended particle mechanism.

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

Text books:

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

References:

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

EEL XXX 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.

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.

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

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

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.

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

References:

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

EEL XXX FLEXIBLE AC TRANSMISSION SYSTEM 3-0-0-6

1. Introduction of semiconductor devices: steady state and dynamic problems in AC systems, power flow.

2. **Flexible AC transmission systems (FACTS**): basic realities & roles, types of FACTS controller, principles of series and shunt compensation.

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).

4. Modelling and analysis of FACTS controllers; control strategies to improve system stability; power quality problems in distribution systems.

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.

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.

References:

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

EEL 1xxx ADVANCED POWER ELECTRONICS 3-0-0-6

1. Resonant DC-DC Converters: operation, characteristics, design equations, control techniques and application; introduction to resonant converters; classification of resonant converters; basic resonant circuit concepts; load resonant converter; resonant switch converter; zero voltage switching, zero current switching, clamped voltage topologies.

2. Switch Mode Power Supply (SMPS): forward, fly back, push pull operation, characteristics, design and control techniques.

3. **Pulse Width Modulation (PWM) technique:** current controlled PWM; voltage source inverters bang-bang, sine PWM and space vector modulation techniques; resonant DC link voltage source inverters operation characteristics, design and control.

4. **Applications of power electronic:** inverters, uninterrupted power supply (UPS), induction heating, metal cutting, active power line conditioning.

Text Book:

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

References:

1. B.K. Bose, Modern Power Electronics & AC drives, Prentice Hall,2003
2. Robert W. Ericson, Fundamentals of Power Electronics, Chapman & Hall, 2001

EEL1xxx 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.

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.

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

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.

Text Books:

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 2003
2. D.K. Cheng, Linear System Analysis, Narosa Publishing House. 1995

EEL1xxx HIGH VOLTAGE DC

3-0-0-6

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

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.

3. Fault development and protection; interaction between AC-DC power systems.

4. Over voltages on AC/DC side, multi-terminal(MT) HVDC systems, control of MT DC systems.

5. Modelling of HVDC systems, per unit system; representation for power flow solution; representation for stability studies.

Text books:

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

References:

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.

EEL1xxx RENEWABLE ENERGY SYSTEMS 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.

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.

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.

4. Modeling and control of wind and solar energy systems.

5**. Optimisation technique-**wind / solar photovoltaic integrated systems design, grid synchronized inverter system.

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.

References:

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.

EEL1xxx 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.

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.

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

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

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

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

References:
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.

EEL1xxx 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