Department of Electrical and Electronics Engineeing
NITK Surathkal

UG Programme: B. Tech. in Electrical and Electronics Engineering

Course Details

1. Course Code: EE101 **Course Title:** Analysis of Electric Circuits **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to analyse the electrical networks for the given excitation.

CO-2: Ability to reduce the complex network into simpler form for analysis.

CO-3: Ability to solve the three phase electrical networks for unknown parameters.

CO-4: Ability to apply the mathematical techniques for solving the differential equations of electrical networks.

Syllabus:

Review of network geometry and network reduction techniques. Network theorems. Network variables, identification of the number of degrees of freedom, the concept of order of a system, establishing the equilibrium equations, network modeling based on energy-indicating (state) variables in the standard form, natural frequencies and natural response of a network. Introduction to system functions, inclusion of forcing functions, solution methodology to obtain complete solution in the time-domain – the vector-matrix approach. Analysis of network response (in the timedomain) for mathematically describable excitations. Solution strategy for periodic excitations. The phenomenon of resonance and its mathematical analysis. Sinusoidal steady state analysis. Introduction to three-phase systems. Magnetic circuit calculations.

References:

- Ernst A. Guillemin, Introductory Circuit Theory, John Wiley and Sons, 1953.
- Norman Balabanian and Theodore A. Bickart – Electrical Network Theory, John Wiley and Sons, Inc. 1969
- Charles A. Desoer, Ernest S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969.
- Russell M. Kerchner, George F. Corcoran, Alternating Current Circuits, 4 th Edition, Wiley Eastern, 1960.

2. Course Code: EE207 **Course Title:** Electromagnetic Theory **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to understand the concepts of electrostatics, electrical potential, energy density.

CO-2: Ability to apply concepts and theories of electrostatics in field calculations.

CO-3: Ability to comprehend the concept of magneto statics, magnetic flux density, scalar and vector potential and their calculations, Faraday’s laws, induced emf and their applications.

Syllabus:

Static electric and magnetic fields. E-fields, D-fields, potential fields & Laplace's equation. Time varying fields. Discussion of various laws like Ohm's, Kirchhoff's, Faraday' s laws from the field theory point of view. Maxwell' equations. Concept of electromagnetic wave propagations, uniform plane wave. Introduction to computational methods in electromagnetics. Applications and analysis of few power engineering related problems.

References:

- William Hayt Jr. , Engineering electromagnetic, John A Buck, 8th Edtn. McGraw Hill Publication, 2012.
- Mathew N O Sadiku, Elements of electromagnetic, 5th edtn, Oxford unvieristy press, 2010.
- John D Kraus and Keith R Carver, Electromagnetics, 2nd Edtn, McGraw Hill Publication, 2012.
- Julius Kdame Strattion, Electromgantics, IEEE press, John Wiley and Sons inc publications, 1981.
- Paul G Huray, Maxwell's equations, IEEE press, John Wiley and Sons inc publications, 2010

3. **Course Code:** EE213 **Course Title:** Electrical Machines-1 **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: To install confidence and comprehend key features of Electric machines like transformers and Induction machines.

CO-2: Be able to select the appropriate types of electric machines based on their characteristics and the specific application requirements.

CO-3: Have knowledge of the operating and safety testing of electric machines.

CO-4: Be able to select the applications and how the machines are used.

Syllabus:

Review of power network structures, principle of energy conversion. Transformers: Principle, construction (single-phase, three-phase), development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers, vector groups and parallel operation of three-phase transformers, tap changers, phase conversion, energisation of transformer and harmonics. Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, Introduction to Solid- state speed control, operation under unbalanced supply conditions and harmonics, effect of single-phasing, induction generator operation. Single-phase induction motor. Testing and diagnostic procedures for machines. Linear induction motor. Laboratory exercises and assignments to supplement the course.

References:

- M. G. Say, Performance and design of A. C. Machines, CBS, 1983
- D P Kothari, I J Nagrat, Electric Machines, 4th edition, TMH, 2010
- E. Fitzgerald, Charles Kingsley, Jr. , Stephan D. Umans, 6th edition, TMH, 2003
- I Elgerd,Patrick D,Electric Power Engineering,2nd edition, Chapman &Hall,1998

4. Course Code: EE224 **Course Title:** Electrical Measurements and Measuring Instruments **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: Knowledge of construction and working of electrical measuring instruments

CO-2: Ability to choose a suitable method of measuring any given electrical quantity

CO-3: Be able to analyse the data obtained as a result of measurement of any given electrical quantity

CO-4: To be able to diagnose and locate the underground cable faults

Syllabus:

Review of units, standards, dimensional analysis. Measurement basics: significant figures, errors, calibration. Measuring instruments: Analog and digital-Concept of true rms, DVM, multimeter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, power, power factor, frequency and energy; Power analyzer. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of low, high resistances and applications. Measurement of earth resistance, dissipation factor and dielectric strength. Basics of cable fault location. Transducers: Classification, strain gauge, RTD, pressure transducers, inductive LVDT, capacitive, thermocouple, piezo-electric. Photo-electric, Hall effect.

References:

- Golding and Widdis, Electrical Measurements and Measuring Instruments, Wheeler Publishing House, New Delhi 1979.
- K. Sawhney, A Course in Electrical Measurement and Measuring Instruments, Dhanpat Rai and Sons, New Delhi 2007
- M. B. Stout, Basic Electrical Measurements C. T. Baldwin, Fundamentals of Electrical Measurement

5. Course Code: EE226 **Course Title:** Analog Electronic Circuits **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: Knowledge of fundamentals of liner integrated circuits.

CO-2: Ability to apply the knowledge gained during the course to design and implement the operational amplifier based various applications for a given specification.

Syllabus:

Terminal, switching and thermal characteristics of semiconductor devices, establishment of quiescent point, biasing considerations, load line concept, control of devices in switching and active zones, device cooling requirement. Introduction to usage of SPICE device models and simulation. Power amplifiers, feedback in amplifiers, filters, operational amplifiers: configurations, characteristics, applications. Sample and hold, A/D, D/A Converters. Multivibrators, voltage regulators, voltage controlled oscillators, phase locked loop. Laboratory exercises and assignments to supplement the course.

References:

- Jacob Millman and A. Grabel, Microelectronics, Tata McGraw-Hill, 1999
- Ramakant Gayakwad, Op-amps and Linear Integrated circuits, Pearson Education, 2007.

- J. V. Wait, L. P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, 2nd Edition,
- McGraw Hill, New York, 1992.
- P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
- S. Sedra and K. C. Smith, Microelectronic Circuits, Saunder's College Publishing, 4th Edition.

6. Course Code: EE143 **Course Title:** Mathematics For Electrical Engineers **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of linear systems.

CO-2: Ability to solve systems of linear equations using matrix algebra.

CO-3: To understand eigen functions and their applications.

CO-4: Application of powerful tools such as Laplace transform, Fourier series, Fourier transform, etc. to solve electrical problems.

Syllabus:

Linear Systems: Systems of linear equations and their solution sets. Matrix Algebra: Matrix Operations, Determinants, Properties of Determinants and Linear transformations. Vector Spaces; Linear Maps, Isomorphism and Norms on vector spaces. Eigen Functions: Eigen Values, Eigen Vectors. Orthogonality and Orthogonal spaces. Integral Transforms: Laplace transforms of elementary functions, Inverse Laplace transforms and applications, Fourier series, Fourier transforms, Fourier cosine and sine integrals, Dirichlet integral, Inverse Fourier transforms

References:

- D avid C. Lay, Linear Algebra and Its Applications, Third Edition, Pearson
- Gilbert Strang, Linear Algebra and Its Applications, Fourth Edition, Academic Press, Cengage
- Learning Kenneth Hoffmann and Ray Kunze, Linear Algebra,, Prentice Hall India
- R. A. Horn and C. R. Johnson, Matrix Analysis, Cambridge University Press.

7. Course Code: EE256 **Course Title:** Signals and Systems **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: Knowledge of basics of signal operation and system response.

CO-2: Exposure and to develop ability to apply different transforms on signals.

Syllabus:

Signals and Systems – Classification, time-domain analysis of continuous-time and discrete-time systems, continuous-time system analysis using the Laplace transform, discrete-time system analysis using the z-transform. Fourier series, Fourier transform, sampling, applications. Laboratory exercises and assignments to supplement the course.

References:

- B. P. Lathi, Linear Systems and Signals, 2nd Edition, Oxford University Press, 2005.
- Simon Haykin, Barry Van Veen, Signals and Systems, John Wiley Asia, 2003.
- V. Oppenheim, A. S. Willsky, S. H. Nawab, Signals and Systems,2nd. Edition, Prentice-Hall Signal Processing Series, 1997

8. Course Code: EE258 **Course Title:** Electrical Machines- II **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: Knowledge of construction and working of dc machine and synchronous machine.

CO-2: Develop ability to model and analyse system.

CO-3: Develop skills of analytical and numerical methods.

Syllabus:

Synchronous machines: Construction, prime-mover and excitation control systems. Steady state characteristics, handling of harmonics, voltage regulation calculations for salient and non salient pole machines, parallel operation, load sharing and associated capacity curves, load-generation balance. Dynamic characteristics, Park transformation, simplified generator models, electromechanical oscillations, concept of power system stability. Introduction to Synchronous motors and condensors, Permanent magnet synchronous motors, Switched reluctance motors. DC Machines: Construction, classification, emf and torque equations, characteristics of DC motors, speed control – Solidstate techniques. Introduction to brushless DC motor, stepper motor, servomotor. Laboratory exercises and assignments to supplement the course.

References:

- M. G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.
- Fitzgerald, Kingsley, Umans, Electric Machinery, 5th Edition, McGraw-Hill, 1992
- Arthur R. Bergen, and Vijay Vittal, Power System Analysis, 1st Edition, Pearson Education Asia, 2001

9. Course Code: EE265 **Course Title:** Power System Engineering I **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Understand the structure of power system.

CO-2: Understand the design, modelling and performance of transmission lines.

CO-3: Knowledge on the impact of transients on transmission lines.

Syllabus:

Electrical energy sources, power network structure and its components. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions, per unit representation, single-line diagram representation, impedance diagram. Analysis of system transients: time-range of transients, traveling waves, low frequency transients. Transmission lines: Design, modeling and performance analysis. Cables, insulators, grounding and safety. power generation and demand management – load factor, diversity factor etc., tariff structure.

References:

- Olle I. Elgerd, Electric Energy Systems Theory – An Introduction, TMH, 1982.
- W. D. Stevenson Jr. , Elements of Power System Analysis, McGraw-Hill, 1968.
- Arthur R. Bergen, and Vijay Vittal, Power System Analysis, Pearson Education Asia, 2001.
- J. Nagrath, D. P. Kothari, Power System Engineering, TMH.

10. Course Code: EE276 **Course Title:** Digital Electronic Circuits **(L-T-P) Credits:** (3-1-3)6

Course Outcomes (COs):

CO-1: Knowledge of fundamentals of digital electronic circuits.

CO-2: Ability to apply the knowledge gained during the course to design and implement the digital electronic circuits based various applications for a given specification.

Syllabus:

Logic families: TTL, ECL, NMOS, CMOS. Number systems, logic gates, boolean algebra, Karnaugh map. Combinational logic circuits: adders, subtractors, multiplexers, de-multiplexers, encoders, decoders, line drivers. Sequential logic circuits: latches and flip flops, registers and counters. Design of following finite state sequential machines using D flip-flops: Sequential code converters, sequence detectors, sequence generators and system controllers. Memories: read only and read/write memories, programming EPROM and flash. Laboratory exercises and assignments to supplement the course.

References:

- M. Mano, "Digital Design", 3rd Ed. , Prentice Hall, India.
- D. D. Givone, "Digital Principles and Design", Tata McGraw Hill. J. F. Wakerly, "Digital Design Principles and Practices", Practice Hall.
- R. J. Tocci, "Digital Systems Principles and Applications", Prentice Hall Charles H Roth: Digital Systems Design using VHDL, Thomson Learning, 1998

11. Course Code: EE308 **Course Title:** Power Electronics **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of high power devise and role of different elements in power electronic converter.

CO-2: Ability to analyse the operation of converter.

CO-3: Ability to identify the design implication of the converter

Syllabus:

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs. Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications.

Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

References:

- Ned Mohan,Undeland, Robbins, Power Electronics, 3rd edition, John Wiley.
- M H Rashid, Power Electronics, 3rd edition, PHI.
- P C Sen, Power Electronics, Tata McGraw-Hill Publishing Company Ltd.
- Bimal K Bose, Modern power electronics and ac drives,PHI. L Umanand, Power Electronics, Wiley India Pvt Ltd.

12. Course Code: EE326 **Course Title:** Linear Control Theory **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understanding of basics of control system

CO-2: Ability to analyse and model the dynamical system.

CO-3: Ability to analyse a control system in time and frequency domain.

Syllabus:

Introduction, classification, mathematical modeling of physical systems, transient response analysis, design specifications and performance indices, concept of stability and algebraic criteria, Root locus analysis, frequency response analysis, Bode diagrams, polar plots, Nyquist plots, stability in the frequency domain, basic control actions, and response of control systems. Introduction to control system design using the root locus and frequency-domain approach. Introduction to state space approach to modeling of dynamic system, canonical forms, concept of controllability, observability, design by state-feedback

References:

- K. Ogata, Modern Control Engineering, 5th Edition, PHI.
- Richard C Dorf, Modern Control Systems, 12th Edition, Pearson Education India.
- J. Nagrath, M. Gopal, Control Systems Engineering, 6th Edition, New Age International.

13. Course Code: EE350 **Course Title:** Power System Engineering-II **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of power system modelling.

CO-2: Ability to analyse power system faults.

CO-3: Ability to apply and develop computer techniques and programs to analyse the power system.

Syllabus:

Review of modeling of power system components: transmission lines, transformers, synchronous machines, loads etc.. System modeling. Steady state analysis: power flow methods. Balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria

References:

- John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994
- P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.
- Olle I. Elgerd, Electric Energy Systems Theory- An introduction, TMH, 1982
- P. W. Sauer and M. A. Pai, Power System Dynamics and Stability, Prentice Hall, Upper Saddle River, New Jersey, 1998.

14. **Course Code:** EE229 **Course Title:** Polyphase Systems And Component-Transformations **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to analyse the star and mesh connected polyphase systems

CO-2: Ability to compute the power and harmonics in polyphase systems

CO-3: Ability to calculate the symmetrical components of the given multiphase systems

Syllabus:

Balanced poly-phase circuits: Generation of poly-phase voltages, Phase sequence, three-phase 3-wire and 4-wire systems, wye and delta connections, n -phase star and mesh, power calculations in balanced systems, harmonics in wye- and delta-systems. Unbalanced poly-phase circuits: unbalanced loads, wye-wye system with and without neutral connections, neutral shift, wye-delta system, phase-sequence effects, extensions to non-sinusoidal behaviour. Introduction to symmetrical components: A brief historical review, application of the method. Calculation of unbalance faults. Multiphase systems: Resolution of multiphase systems into symmetrical components, 2-phase and 4-phase systems, Irregular systems.

References:

- Edith Clarke, Circuit Analysis of AC Power Systems – Volumes I and II, John Wiley and Sons, 1950.
- C. F. Wagner, R. D. Evans. Symmetrical Components, McGraw-Hill, 1933.
- J. L. Blackburn, Symmetrical Components for Power System Engineering, Marcel-Dekker,1993.

15. **Course Code:** EE253 **Course Title:** Commutator Machines **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Details about the action of commutator will be known.

CO-2: Design of the machine windings in the commutator machines when machine is subjected to Faults.

Syllabus:

Constructional details, commutator action analysis, windings, mmf production, limitations, special features, fields of application, fault detection and general maintenance, preliminary design.

References:

E. Openshaw Taylor, The Performance and Design of AC Commutator Machines.

Fitzgerald, Kingsley, Kusko. Electromechanical Energy Conversion.
Atkinson, Generalized Machine Theory.

16. Course Code: EE255 **Course Title:** Introduction to Algorithms and Data Structures **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand mathematical basics of algorithms and fundamentals concepts of data structures.

CO-2: To understand the sorting, divide – and – conquer paradigms in an algorithmic design situation.

CO-3: To synthesize greedy and dynamic programming algorithms.

CO-4: Evaluate the major graph algorithms to model engineering problems.

Syllabus:

Mathematical basis and notions for algorithm analysis. Sorting, divide and conquer, linear time sorting, elementary data structures, priority queues, BST and RBT. Design and analysis. Paradigms Dynamic programming, Greedy algorithms, Graph algorithms.

References:

- T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, PHI, 2004.
- D. E. Knuth, The Art of Computer Programming, Volumes I and III, Addison-Wesley, 1973.
- Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 2003.

17. Course Code: EE260 **Course Title:** Digital Computer Organization and Architecture **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of basic concepts and structure of computers.

CO-2: Elaborated knowledge of the I/O and memory organization.

Syllabus:

Evolution of computers, instruction set design, processor design: functional unit design, micro-programmed and hardwired approaches, different architectures, control unit design, memory organization, input-output organization, introduction to system software, operating system basics.

References:

- J. P. Hayes, Computer Architecture and Organisation, 2nd Edition, McGraw-Hill, 1988.
- M. Rafiquzzaman, Rajan Chandra, Modern Computer Architecture, Galgotia, 1999.

18. Course Code: EE281 **Course Title:** Commutator Machine Labortory **(L-T-P) Credits:** (0-3-0)2

Course Outcomes (COs):

CO-1: Ability to implement winding diagrams using software implementation.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE253.

19. Course Code: EE295 **Course Title:** Electric Machine Winding Calculations- I **(L-T-P) Credits:** (0-2-3)4

Course Outcomes (COs):

CO-1: Understanding the geometrical layout of armature windings

CO-2 Ability to design and estimation of machine parameters

Syllabus:

An exposition of the magnetic and electric circuits of commutator-wound machines. Exercises involving: the geometrical layout of the armature windings, brush placement, interpoles, equalizing rings. Detailing of the process of commutation and of armature reaction. Calculations in respect of winding design and of estimation of machine parameters from design data.

References:

- Clayton A. E. Hancock N. N. , "The Performance and Design of Direct Current Machines", 3rd Edition, Oxford & IBH, 1986 (Indian Reprint).
- Taylor O. E., "The Performance and Design of AC Commutator Motors", A. H. Wheeler & Co. 1988 (Indian Reprint).

20. Course Code: EE296 **Course Title:** Electric Machine Winding Calculations- II **(L-T-P) Credits:** (0-2-3)4

Course Outcomes (COs):

CO-1: Understanding the geometrical layout of armature winding for open wound ac machines, salient and non-salient pole windings

CO-2: Ability to calculate the harmonics for cage rotor and damper windings

Syllabus:

An exposition of the magnetic and electric circuits of open-wound (AC) machines. Salient- and non-salient-pole windings. Exercises involving: the geometrical layout of armature windings, armature reaction, harmonics and their quantification, cage rotor, and damper windings. Estimation of machine parameters from design data

References:

- Say M. G, "The Performance and Design of Alternating Current Machines", 3rd Edition, CBS, 1983 (Indian Reprint).
- Langsdorf A. S. "Theory of Alternating Current Machinery", 2nd Edition, Tata McGraw-Hill, 1974.

21. Course Code: EE298 **Course Title:** Elements of Analog and Digital Communication **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Understand the basics of communication system, analog and digital modulation techniques.

CO-2: Summarize different types of communication systems and its requirements.

CO-3: Apply the knowledge of digital electronics and understand the error control coding techniques.

Syllabus:

Introduction to analog and digital communication: Bandwidth and information capacity, transmission modes, signal analysis, noise considerations. Modulation and demodulation concepts: AM, FM, PM, TDM and FDM concepts. Classification of amplifiers (Class A, B, and C), tuned amplifiers, oscillators, amplitude modulation, demodulation circuits, mixer, TRF, super heterodyne and direct conversion receivers. Monochrome TV transmitter and receivers. Digital and data communication: Sampling theorem, coding and decoding, pulse modulation, FSK, PSK, Modem. Serial and parallel interface: Computer network configurations and protocols, OSI reference model, internet protocol, packet switching. Satellite communications, orbital patterns, geostationary satellites, frequency band allocation. Optical fibre communication: Mode of signal transmission, signal sources and detectors, attenuators and channel capacity. Digital telephony, PSTN and cellular telephony.

References:

- Wayne Tomasi, Electronic Communication Systems, 4th Edition, Pearson Education, 2002.
- Kennedy, Communication Systems, 4th edition.
- Gary Miller, Modern Electronic Communication, 7th Edition.
- Andrew S. TanenBaum, Computer Networks, 3rd Edition.
- William C. Y. Lee, Mobile Cellular Telecommunication, 2nd Edition.

22. Course Code: EE303 **Course Title:** Distribution System Planning and control **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of distribution system planning and control.

CO-2: Ability to analyse the distribution system.

CO-3: Ability to design automated distribution system.

CO-4: Ability to diagnose and troubleshoots distribution systems.

Syllabus:

Distribution systems, their importance in energy transfer, distribution loss minimization techniques, radial and ring system, voltage regulation, reconfiguration, capacitor placement, power flow analysis, sizing of conductors and transformers, fault analysis, data acquisition and control, remote reading of energy meter, role of computers in distribution system operation, state of the art.

References:

- T. M. Gonen, Electrical Energy Distribution.
- C. L. Wadhwa. , Electrical Energy Distribution.
- Recent publication in reputed journals and conference proceedings of relevance.

23. Course Code: EE311 **Course Title:** Digital System Design **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Impart skills to build small and medium level system controller using discrete digital circuits.

CO-2: Ability to design system controllers for various automation applications using PLDs and EDA

Syllabus:

Review of combinational logic design using PLD, design of synchronous sequential logic systems, introduction to VHDL, design of system controllers, design of systems using PLD / FPGA, fundamentals of data converters.

References:

- C. H. Roth, Digital System Design, PWS, 1998.
- J. F. Wakerly, Digital Design, PHI, 3rd Edition. , 2001
- W. Fletcher, An Engineering Approach to Digital Design, PHI.
- M. J. Sebastian Smith, Application Specific Integrated Circuits, Addison-Wesley, 1999.

24. Course Code: EE312 **Course Title:** Power System Harmonics **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To identify the sources of harmonics in power systems.

CO-2: To understand the effects of harmonics in power systems and in communication systems.

CO-3: Ability to solve single-phase and three-phase systems under non-sinusoidal conditions.

CO-4: Knowledge of power quality parameters and various harmonic mitigation techniques.

Syllabus:

Harmonic Sources: Power electronic converters, transformers, rotating machines, arc furnaces, fluorescent lighting. Harmonic effects within power system- resonances, harmonic torques, static power plant, control systems, power system protection, consumer equipment, measurements, and on power factor. Harmonic effects related to communication interference: telephone circuit susceptiveness, harmonic weights, I-T and kV-T products, shielding. Harmonic effects related to biological effects. Power theory, single and three-phase, non -sinusoidal conditions, Fryez and Budeno's methods. Power quality parameters. Transducers and data transmission, Hall effect voltage and current sensors. Harmonic mitigation techniques: passive filters, active filters. Algorithms for extraction of harmonic current in the line.

References:

- J. Arrillaga, Power System Harmonics, IEE Press.

25. Course Code: EE313 **Course Title:** Digital Signal Processing **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Understand the operations on digital signals

CO-2: Analyze the signal processing concepts

CO-3: Design the systems required for digital signal processing.

Syllabus:

Review of FT, DTFT, DFT. Circular Convolution, DFT computation methods: Radix FFTs: Decimation in time and Decimation in frequency FFT, DCT. IIR Filters: Analog filters: properties and design of Butterworth, Chebychev and Elliptical filters. Frequency transformation. Review of Z-transform and its properties. Structure of digital filters. Methods of converting analog filters to digital filter (IIR): bilinear transformation, pole-zero mapping, Impulse invariant transformation. Methods of designing the FIR filters: window- based methods, frequency sampling method. Introduction to the programmed digital systems. General architecture of Digital Signal Processors, programming of the TMS320F243, application of DFT for linear filtering.

References:

- John G. Proakis, D. G. Manolakis, Digital Signal Processing.
- Ashok Ambardar, Analog and Digital Signal Processing.
- L. R. Rabiner, B. Gold, Theory and Applications of Digital Signal Processing, PHI, 1975
- Richard G. Lyons, Understanding Digital Signal Processing.
- Roman Kuc, Introduction to Digital Signal Processing.

26. Course Code: EE319 **Course Title:** Neural Networks and Applications **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Knowledge on the development of artificial neural networks (ANN) and classify various ANN models.

CO-2: Understanding of various ANN training algorithms and pattern recognition techniques.

CO-3: Knowledge on construction of ANN models to various applications of electrical systems

Syllabus:

Introduction: Biological neuron, Mc-Culloch -Pitts neuron model. Various threshold functions, Feature vectors and feature space. Classification techniques – nearest neighbor classification. Distance metrics, linear classifiers, decision regions. The single layer and multilayer perception, multilayer perception algorithm, solution of the XOR problem, visualizing the network behaviour in terms of energy functions, Mexican hat function. Learning in neural networks, linearly non-separable pattern classification, delta learning rule. Error back-propagation training algorithms, Feedback networks - Hopfield network, energy landscape, storing patterns, recall phase, Boltzmann machine, traveling salesman problem. Associative memories, retrieval and storage algorithm, stability considerations. Application of neural systems - linear programming, modeling networks, character recognition, control system applications, robotic applications.

References:

- R. Beale, T. Jackson, Neural Computing: An Introduction, IOP Publishing Ltd. , 1990.
- Jack H. Zaruda, Introduction to Artificial Neural Systems, Jaico Publications.

27. Course Code: EE320 **Course Title:** Electrical Safety, Operations, Regulations **(L-T-P) Credits:** (3-0-0)3

Course Outcomes (COs):

CO-1: Knowledge of electrical safety: safety of the self/public and equipments

CO-2: Understand the guidelines on earthing and protection

CO-3: Understand the various electrical safety regulations, IEEE standards, and Indian electricity rules.

Syllabus:

Electrical safety: Safety of the self. Safety of the equipment, Safety of the public. PPE. General guidelines on earthing and protection. Operations: Sign boards, tagging system and procedures. Safe operating procedures, case studies and, safety audit basics. Regulations: IS, IEEE standards, Indian Electricity rules and regulations.

References:

- HSC- A Practical guide VOL. 1 to 4, National Safety Council, India.
- IS 5216 (Part I)- 1982, "Recommendations on safety procedures and practices in electric work".
- SP 30 -1985 Special publication-National Electric Code, "Section-14: Electric Aspects of building services".
- IEEE Standard 902.

28. Course Code: EE321 **Course Title:** Linear And Nonlinear Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understand the characteristics of linear and non-linear systems

CO-2: Ability to model and analysis linear time-invariant/variant systems

Syllabus:

Characteristics of linear systems, modeling and analysis of linear time-invariant systems using state-space approach, analysis of linear time-variant systems. Characteristics of nonlinear systems, common types of nonlinearities, phase plane analysis, describing function analysis.

References:

- Thomas Kailath, Linear Systems, Prentice-Hall, 1980.
- K. Ogata, State-Space Analysis of Control Systems, Prentice-Hall, 1967. John E. Gibson, Non linear Automatic Control, McGraw-Hill, 1963.

29. Course Code: EE324 **Course Title:** Electronic Measurements and Instrumentation **(L-T-P) Credits:**(3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of construction and working of electronic instruments such as oscilloscopes and transducers

CO-2: Ability to choose a suitable method of measuring any given electrical and electronic quantities.

CO-3: Ability to analyse the data obtained as a result of measurement of any given electronic quantity

Syllabus:

Measurement systems, electromechanical instruments, bridges, electronic instrumentation, oscilloscopes, signal analysis, frequency, time interval measurements, physical parameter measurements, transducers, data acquisition systems.

References:

- B. H. Oliver, J. M. Cage, Electronic Measurements and Instrumentation, McGraw-Hill, 1975
- Albert D. Helfrick, William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, PHI.

30. Course Code: EE328 **Course Title:** Network Synthesis **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of mathematical tools for network synthesis

CO-2: Understand the realizability conditions for networks with and without transformers

CO-3: Understand the concept of positive real functions and driving point synthesis with RLC elements.

Syllabus:

Review of mathematics for network synthesis Partial -fraction expansion, Continued – fraction expansion, Bilinear transformation. The positive real concept - Hurwitz polynomials, analytic tests for positive real functions, positive -- definite and positive -- semi -- definite quadratic forms. Realizability conditions for networks with and without transformers (magnetic coupling) Realization of driving -- point functions -- Canonical forms – LC, RC, and RL driving -point functions.

References:

- Louis Weinberg, Network Analysis and Synthesis, McGraw – Hill, New York, 1962 M. E.
- Van Valkenburg, Modern Network Synthesis, Prentice – Hall, New Jersey.

31. Course Code: EE329 Course Title: Travelling waves on Transmission systems (L-T-P) Credits: (3-1-0)4

Course Outcomes (COs):

CO-1: To understand the phenomenon of attenuation, distortion and reflection of travelling waves.

CO-2: To understand the theory of travelling waves on multi-conductor systems.

CO-3: To acquire knowledge about multi velocity waves and successive reflections.

CO-4: To understand high frequency effects of travelling waves.

Syllabus:

Introduction to the line equations. Attenuation and distortion of traveling waves. Reflection of traveling waves. Successive reflections: The reflection lattice, construction and use of the lattice-diagram, Charging of a line from various sources, Reflection between a capacitor and a resistor, effect of short lengths of cable, effect of insulator capacitance. Traveling waves on multi conductor systems. Theory of ground-wires: Direct stroke to a tower, effect of reflections up and down the tower, tower grounding. The counterpoise: Multi velocity waves on the counterpoise, tests on the counterpoise, successive reflections on the insulated counterpoise. Induced lightning surges: The field gradient, induced surges with ideal ground wires. Arcing grounds: Normal frequency arc extinction – single-phase and three-phase, oscillatory- frequency arc extinction, high-frequency effects, interruption of line-charging currents, cancellation waves, initiated waves, steady-state waves, recovery voltage, restriking phenomena.

References:

- L. V. Bewley, Traveling Waves on Transmission Systems, John Wiley and Sons, 1951.
- H. H. Skilling, Electric Transmission Lines, McGraw-Hill, 1951.
- L. F. Woodruff, Principles of Electric Power Transmission, John Wiley and Sons, 1952 .

32. Course Code: EE331 Course Title: Distribution Systems Laboratory (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: ability to evaluate the distribution system performance.

CO-2: ability to comprehend the data acquisition system and remote monitoring of energy systems.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE303.

Distribution systems, their importance in energy transfer, distribution loss minimization techniques, radial and ring system, voltage regulation, reconfiguration, capacitor placement, power flow analysis, sizing of conductors and transformers, fault analysis, data acquisition and control, remote reading of energy meter, role of computers in distribution system operation, state of the art.

References:

- T. M. Gonen, Electrical Energy Distribution.
- C.L. Wadhwa. , Electrical Energy Distribution.
- Recent publication in reputed journals and conference proceedings of relevance.

33. Course Code: EE334 **Course Title:** Power Electronics Laboratory **(L-T-P) Credits:** (0-0-3)3

Course Outcomes (COs):

CO-1: Ability to obtain characteristics of power electronic devices practically.

CO-2: Ability to design and built a power electronic converter.

CO-3: Ability to use simulation softwares for analyzing power electronics circuits and converters.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE308 [Power Electronics].

References:

- Ned Mohan,Undeland, Robbins, Power Electronics, 3rd edition, John Wiley.
- M H Rashid, Power Electronics, 3rd edition, PHI.
- P C Sen, Power Electronics, Tata McGraw-Hill Publishing Company Ltd.
- Bimal K Bose, Modern power electronics and ac drives,PHI.
- L Umanand, Power Electronics, Wiley India Pvt Ltd

34. Course Code: EE335 **Course Title:** Digital System Design Lab **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: Skills to build small and medium level system controller.

CO-2: Ability to design system controllers for various automation applications using FPGA.

CO-3: Familiarize with the electronic design automation tools/VHDL: XILNIX foundation tools.

Syllabus:

VHDL / Verilog programming, design exercises on ECAD software, hardware realization on FPGA / CPLDs, to provide additional support to EE311

35. Course Code: EE337 **Course Title:** Power System Harmonics Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: To gain knowledge of power system harmonics through Simulations

CO-2: To verify theoretical findings of power system harmonics through experimental studies

Syllabus:

Laboratory Exercises and assignments to provide additional support to EE312. Experiments around MATLAB®, PSCAD®, OrCAD™ and laboratory measurement exercises.

36. Course Code: EE342 **Course Title:** Electronic Measurements Laboratory **(L-T-P) Credits:** (0-0-3) 2

Course Outcomes (COs):

CO-1: Knowledge of measuring resistance, inductance and capacitance using bridges

CO-2: Ability to choose a suitable method of measuring any given physical parameter measurement

CO-3: Ability to analyse the data obtained as a result of measurement of any given quantity

Syllabus:

Laboratory exercises and assignments to support EE324.

37. Course Code: EE343 **Course Title:** Statistical Foundation for Electrical Engineers **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understand and describe sample spaces and events for random experiments. Interpret and calculate probabilities of events in discrete sample spaces.

CO-2: Use probability as a tool to develop probability distribution that serve as models for any random variables

CO-3: Distinguish any discrete distribution from continuous probability distributions. Apply these models in different physical situations.

CO-4: Application of estimation techinques

Syllabus:

Probability: Axioms, Sample spaces (continuous & discrete), Density, Distribution and Mass functions and their a pplications. Random Variable: Single, Multiple, Continuous and Discrete, statistical operations and limit theorems. General Distributions and their practical significance. Functions of random variables: Probability distribution functions of functions of random variables. Random Process: Concept, Classification, Temporal and Spectral characterization, and Statistical Estimation: Estimation of variables, Estimation of parameters. Testing of hypothesis. Analysis of linear systems to Random signals and optimum linear systems, and Optimum Wiener Solutions.

References:

- Davenport W. B Jr, Probability and Random Process, An Introduction for Applied Scientists and
- Engineers, McGraw-Hill.
- Peyton Z. Peebles JR, Probability, Random Variables & Random Signal Principles, 4thEdition, McGraw-Hill.
- Leon-Garcia, Probability and Random Process for Electrical Engineering, Addition-Wesley.
- Viniotis Y, Probability and Random Process for Electrical Engineers, McGraw-Hill.

38. Course Code: EE359 **Course Title:** Energy Auditing **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge about need for energy audit

CO-2: Identification of energy conservation opportunities in various industrial processes

CO-3: Gain knowledge on tools and techniques employed in energy auditing

Syllabus:

Introduction to energy audit. Purpose, methodology, case studies of few selected industries, analysis of results and inference, standards, instruments used in energy auditing.

References:

- Shirley J. Hansen, James W. Brown, Jim Hansen, Investment Grade Energy Audit, Marcel Dekker, 2003.
- Donald R. Wulfinghoff, Energy Efficiency Manual, Energy Institute Press.

39. Course Code: EE360 **Course Title:** Microprocessors **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of architecture and assembly language programming of microcontroller and microprocessor.

CO-2: Ability to design and develop the microcontroller/ microcontroller based application along with the ALP.

Syllabus:

Basics of finite state machines, Von Neumann Architecture, functional blocks of a microcomputer, architecture of 8- bit/16-bit Microprocessors/Microcontrollers [viz. Intel 8051 family, MOTOROLA 68HXX, ARM Core etc.]. Programmers' model of any one microprocessor/microcontroller chosen for detailed study, instruction set, chip configuration and programming, use of development and debug tools, interface applications. Laboratory exercises.

References:

- Intel Corporation, 8-bit Microcontroller Handbook, Intel Corporation, 1990.

- ARM® Core Processor Hand book. John B. Peatman, Design with Microcontrollers, McGraw-Hill, 1995.
- Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield, ARM System Developer's Guide, Designing and Optimizing System Software, Elsevier, 2004.

40. Course Code: EE361 **Course Title:** Power System Communications **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to compute the power line channel capacity and design modulation schemes.

CO-2: Ability to explain and analyse the EMC problems

Syllabus:

The Electric power supply and its properties, historic development of data communication over power lines, The European CENELEC standard EN50065, channel characteristics, coupling and measuring techniques at high frequencies for PLC, estimating power line channel capacity, EMC problems and solutions, modulation schemes for PLC, communication over the electric power distribution grid.

References:

- Klaus Dostert, Franzis Verlag, Power Line Communications, PHI.

41. Course Code: EE362 **Course Title:** Operation and Control of Power Systems **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Knowledge on how to calculate various factors (such as load factor and demand factor, etc.) and interpret different tariff structures.

CO-2: Development of generation dispatching schemes for thermal units.

CO-3. Knowledge on frequency control and reactive power compensation schemes in power system.

CO-4: Adopt engineering innovations for improved power system operation.

Syllabus:

Economic operation of power systems: Economic load dispatch, unit commitment. Load frequency control: Modeling of components of generating systems, concept of coherent units, operation of single area. Introduction to multi-area systems. Sources of reactive power. Introduction to contingency analysis. State estimation: Importance of state estimation, DC state estimation. Energy interchange evaluation.

References:

- O. I. Elgerd, Electric Energy Systems Theory: An Introduction, McGraw-Hill, 1971.

- J. Nagrath, D. P. Kothari, Modern Power System Analysis, TMH.
- S. S. Rao, Optimisation Theory and Applications.
- Allen J. Wood, Bruce F. Wollenberg, Power Generation Operation and Control, 2nd Edition, John Wiley and Sons,1996.

42. Course Code: EE363 **Course Title:** Advanced Digital Signal Processing **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of analysis of discrete time signals.

CO-2: Knowledge of modern digital signal processing algorithms and applications.

Syllabus:

Time frequency analysis, time frequency distribution, short time Fourier transforms. Multirate signal processing: Decimation interpolation, DFT filters banks, QMF filter banks. Multiresolution signal analysis. Wavelets theory of subband decompositions, sub band coding and wavelet transforms, application of wavelet transforms. Homomorphic signal processing: Homomorphic system for convolution, properties of complex spectrum, applications of homomorphic deconvolution. Multi-dimensional signal processing: Review of convolution and correlation. 2-D signals. Linear estimation of signals and applications: Random signals, linear prediction and applications (deconvolution, least square filters). Recursive estimation and Kalman filters. Adaptive signal processing: Adaptive filters and applications.

References:

- P. P. Vaidyanathan, Multirate Systems and Filter Banks, PH, 1993.
- S. J. Orfanidis, Optimum Signal Processing, McGraw-Hill, 1989.
- John G. Proakis, D. P. Manolakis, Introduction to DSP, Pearson, 2002.
- E. C. Ifeachor, B. W. Jervis, Digital Signal Processing: A Practical Approach, Pearson Education.

43. Course Code: EE366 **Course Title:** Special Machines and Drives **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of construction and working of special machines.

CO-2: Develop skills to handle the present day industrial drivers and the associated machines.

Syllabus:

Method of control and application of brushless DC motor, PMSM, stepper motor, AC servomotor, universal motor. Electric drive, motor rating, heating effects, electric braking, modification of speed-torque characteristic of an induction motor by V/f control, starting and braking. Synchronous motor -- Speed torque and torque angle characteristics by V/f control, braking

References:

- G. K. Dubey, Fundamentals of Electrical Drives, Narosa.

- A . E. Fitzerald, C. Kingsley, S. D Umans, Electric Machinery, McGraw-Hill.
- S. K. Pillai, A First Course on Electric Drives, Wiley Eastern, 1990.

44. **Course Code:** EE369 **Course Title:** Embedded System Design **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Imparts design skills to build small and medium level system controller.

CO-2: Ability to design system controllers for various application using programmable controller.

Syllabus:

Embedded controllers, basic requirements, design of embedded systems, system on chip concept. VLSI CAD application. Case study: DSP/microprocessor based or FPGA based system design.

References:

- Charles H. Roth, Digital System Design using VHDL, PWS, 1998.
- User manuals of Microprocessor /DSPs

45. **Course Code:** EE371 **Course Title:** Power Electronics Applications To Power Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to explain the basic principles, characteristics of different types of FACTS controllers.

CO-2: Ability to compare the performance of various FACTS controllers.

CO-3: Ability to model FACTS controller for power flow and stability applications.

CO-4: Ability to select a suitable FACTS controller for a particular application

CO-5: Describe control strategies used in HVDC system with HVDC converters and multi terminal dc system

Syllabus:

HVDC systems: Classical HVDC systems, CCC systems, HVDC Light systems. Application of FACTS devices such as SVC, TCSC, SSS, UPFC to improve steady state and dynamic behaviour of power systems. Modeling of HVDC systems and FACTS devices to perform system studies.

References:

- N. G. Hingorani, L. Gyugi, Understanding FACTS, IEEE Press, 2001.
- P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.

46. **Course Code:** EE373 **Course Title:** Electric Power Stations **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of selecting sites for different power plants

CO-2: Knowledge of working requirements of thermal, hydro and nuclear power plants

CO-3: Knowledge of load forecasting, understanding substation layouts etc.

Syllabus:

Choice of site for power plants. Thermal power plant: General layout, air and flue-gas circuit, fuel and ash handling circuit, cooling water circuit, steam and feed water circuit. Nuclear power plant: General layout, heat exchangers, moderators, coolants, control rods. Hydro power plant: Site selection, general layout, type of hydropower plants, hydrographs. Characteristics of hydro turbines. Electrical equipment in generating stations: General layout, excitation systems and voltage regulation. Substation layout, components of substation. bus-bar arrangements, current-limiting reactors and their location. Safety and coordination. Load forecasting and sharing: Load curve and load duration curves, load factor, diversity factor, plant factor and plant use factor, demand factor, load sharing between base and peak load stations.

References:

- M. V. Deshpande, Electrical Power Stations.
- Tata Electric Co., Operator Training Manual

47. **Course Code:** EE374 **Course Title:** Electric Energy Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to explain the basic principles of power system instrumentation and control

CO-2: Ability Illustrate the boiler operation and its control in a thermal power plant.

CO-3: Ability to perform the energy audit and take decision on energy conservation methods

Syllabus:

Conventional and non- conventional energy sources and systems: Generation, transmission and distribution schemes, energy conservation systems, energy efficient equipment and controllers. Energy audit.

References:

- Olle I. Elgerd, Electric Energy System Theory: An Introduction, TMH, 1982.
- I. J. Nagrath, D. P. Kothari, Power System Engineering, TMH.

48. Course Code: EE376 **Course Title:** Advanced Control Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to model linear time invariant systems with the help of state-space formulation from differential equation.

CO-2: Perform discrete-time analysis of systems and understand its relation to continuous-time system analysis.

CO-3: Ability to design advanced control techniques based on state feedback design and optimal control.

CO-4: Understand the concept of controllability and observability and design of state observers.

Syllabus:

Introduction, review of state space approach to modeling of dynamic system. Introduction to discrete time control system, Signal processing in digital control, models of digital control devices and systems, z -plane analysis of discrete time control system, transient response analysis, design specifications and performance indices, design of digital control algorithms, state variable analysis of digital control systems, Pole placement design and state observers, linear quadratic optimal control

References:

- K. Ogata, Discrete Time Control Systems, 2nd Edition, Pearson
- Education. M. Gopal, Digital Control and State Variable Methods, TMH.

49. Course Code: EE377 **Course Title:** Modelling and Simulation Techniques for Dynamic Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understand the dynamics associated with different types of system from across the engineering disciplines.

CO-2: Ability to describe the given system in the form of linear ordinary differential equations and other alternate representations such as bond graphs.

CO-3: Develop an understanding of frequency domain representation and draw inference from such a system representation.

Syllabus:

Introduction to system dynamics, transfer function approach to modeling dynamic systems, modeling of electrical and electromechanical systems, mechanical systems, state-space approach to modeling dynamic systems, Bond graphs method, transient analysis of dynamic systems, frequency domain analysis of dynamic systems, numerical techniques applied to dynamic systems.

References:

- MathWorks Inc. , MATLAB®/ SIMULINK™ Reference/User Manuals, MathWorks Inc.
- K. Ogata, System Dynamics, 4th Edition, Pearson Education.
- K. Ogata, Discrete Time Control Systems, 2nd Edition, Pearson Education.

50. Course Code: EE378 **Course Title:** Shell Scripting With Bash **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to write shell scripts for automating tasks on Linux environment.

CO-2: Understand the details of shell commands.

Syllabus:

The Linux environment: Files and file systems, directories, inodes and links, pipe and socket files, device files. Operating the shell, Bash keywords, command basics, command-line editing; files, users and shell customization, working with files. Script basics, creating a well-behaved script, basic redirection, standard output, error and input, built-in versus Linux commands. Variables: Basics and attributes, bash pre-defined variables, expressions, arithmetic and logical expressions, relational, bitwise and self-referential operations, substitutions. Compound commands, debugging and revision control, shell archives, parameters and subshells, job control and signals. Text file basics, text file processing, console scripting, functions and script execution. Shell security aspects and network programming. Related shells and the IEEE 1003. 2 POSIX shell standard.

References:

- Cameron Newham, Bill Rosenblatt, Learning the Bash Shell, O'Reilly Media, 2005.
- Arnold Robbins, Nelson H. F. Beebe, Classic Shell Scripting, O'Reilly Media, 2005.
- Ken O. Burtch, Linux Shell Scripting with Bash, Sams Publishing, 2004.
- Stephen G. Kochan, Patrick Wood, Unix Shell Programming, 3rd Edition, Sams Publishing, 2003. Mendel
- Cooper, Advanced Bash-Scripting Guide,2005. (Available on-line in pdf at http://www. tldp. org/)

51. Course Code: EE379 **Course Title:** Incremental Motion Control **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Knowledge of principles of operation of various types of stepper motors

CO-2: Ability to choose a suitable controller for stepper motors.

CO-3: Ability to analyse the static and dynamic torque characteristics of stepper motors

Syllabus:

Introduction to incremental motion systems, Principles of operation of various types of stepper motors, static and dynamic torque characteristics of stepper motors, open loop and closed loop controls, microprocessor-based controllers for stepper motors.

References:

- P. P. Acarnley, Stepping motors-A Guide to Modern Theory and Practice, 3rd Edition, Peter Peregrinus, 1992.
- Takashi Kenjo, Akira Sugawara, Stepping Motors and their Microprocessor controls, 3rd Edition, Oxford University Press, 2005.

52. Course Code: EE382 **Course Title:** Virtual Instrumentation Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: To demonstrate the working of LabVIEW.

CO-2: To analyse different types of programs based on data acquisition.

CO-3: To demonstrate the various techniques of interfacing using LabVIEW.

CO-4: To use LabVIEW and configure the DAQ and related hardware.

Syllabus:

LabVIEW programming, data acquisition with LabVIEW™ DAQ VIs, interfacing with GPIB and RS232/RS485.

53. Course Code: EE384 **Course Title:** Energy Auditing Laboratory **(L-T-P) Credits:** (0-0-3) 2

Course Outcomes (COs):

CO-1: Knowledge on inspection survey and analysis of **energy** flows for **energy** conservation in a building/industry.

CO-2: Understand energy consumption & Identify cost saving opportunities.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE359.

54. Course Code: EE385 Course Title: Microprocessors Laboratory (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller.

CO-2: Work with standard microprocessor real time interfaces including GPIO, serial ports, digital-to-analog converters and analog-to-digital converters

Syllabus:

Programming and interfacing experiments on the target processor / microcontroller discussed in EE360.

55. Course Code: EE386 Course Title: Digital Signal Processing Laboratory (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: Ability to apply concepts learned in the theory course in practical scenario.

CO-2: Get introduced to the digital signal processing tools available in computational software, primarily Matlab.

Syllabus:

Laboratory exercises and assignments to enhance learning of DSP.

References:

- M ATHEMATICA®, LabVIEW™, DSP programming. Exercises around
- MATLAB®, S. Burrus et al, Computer Based Exercises for Signal Processing, PH, 1994. S. K. Mitra, DSP: A Computer-Based Approach, TMH, 1998.

56. Course Code: EE387 Course Title: Advanced Digital Signal Processing Laboratory (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: ability to implement a coding in the DSP processor to execute the given algorithm.

CO-2: ability to design the control techniques using DSP processor.

Syllabus:

Laboratory exercises and assignments to to provide enhance learning of advanced DSP techniques and algorithms.

57. Course Code: EE389 **Course Title:** Embedded System Design Lab **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: Imparts design skills to build small and medium level system controller.

CO-2: Ability to design controllers using PL/ Programmable controller

CO-3: Familiarize to cross compliers/ Assemblers as development tools

Syllabus:

Laboratory exercises and assignments to provide additional support to EE369.

58. Course Code: EE392 **Course Title:** Power System Operation Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: Ability to find the optimum unit commitment for a power system

CO-2: Ability to calculate the economic load dispatch for a system comprised of n thermal plants.

Syllabus:

Simulation exercises and assignments to provide additional support to EE362. Experiments around MATLAB®, PSCAD®, PowerWorld™ and SKM® packages.

59. Course Code: EE393 **Course Title:** Dynamic System Simulation Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: Knowledge of transfer function and SS approach for modeling dynamic system.

CO-2: Ability to perform transient and frequency domain analysis of the dynamic system.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE377.

60. Course Code: EE402 **Course Title:** HVDC transmission **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To develop the knowledge of HVDC transmission and HVDC converters.

CO-2: To analyse the rectifier and inverter control methods and the impact of firing angles.

CO-3: To understand the models of filters and types of protection.

CO-4: To acquire knowledge about the advancements in VSC-HVDC and MTDC systems.

Syllabus:

Need, Basic principle of conversion, economics of different configurations, The Graetz bridge circuit, analysis, overlap, firing delay, inversion, converter control, tap-changing control, power reversal, measuring devices, filters, circuit breaker, lighting arrester, DCCT, MRT. MTDC systems, interaction between AC and DC Systems, voltage stability, power modulation, Introduction to Voltage Source Converter based HVDC System, future of the HVDC transmission systems, research and development.

References:

- E. W. Kimbark, Direct Current Transmission.
- K. R. Padiyar, Power Transmission by Direct Current, Wiley Eastern, 1990.
- Recent Publications of relevance.

61. Course Code: EE404 **Course Title:** Soft Computing and Applications **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of soft computing theories and approaches to solve real world problem.

CO-2: Ability to design and develop applications using artificial neural network and fuzzy logic controller.

Syllabus:

Introduction to intelligent systems and soft computing, Intelligent systems, Knowledge-based systems, Knowledge representation and processing. Soft computing, Fundamentals of fuzzy logic systems, Fuzzy Sets, operations, relations, fuzzy logic, fuzzy control, Composition and inference, Considerations of fuzzy decision-making, neural networks – Single layer, multilayer networks, Features of artificial neural networks, learning, Fundamentals of connectionist modelling, BP algorithm, Major classes of neural networks, The multilayer perceptron, Radial basis function networks, Kohonen's self-organizing network, Industrial and commercial applications of ANN such as optimal control, manufacturing, power systems, robotics, etc. , neuro-fuzzy systems, Architectures of neuro-fuzzy systems, Neural network- driven fuzzy reasoning, Hybrid neuro-fuzzy systems, Construction of neuro-fuzzy systems, Evolutionary computing, Integration of genetic algorithms with neural networks, Integration of genetic algorithms with fuzzy logic, Known issues in GA and applications.

References:

- Karray, Fakhreddine O. , and Clarence W. De Silva. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education, 2004.
- J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing – A Computational Approach to Learning and Machine Intelligence, PHI, 2002.
- M. Negnevitsky, Artificial Intelligence, A Guide to Intelligent Systems, Pearson Publishing, 2006
- C. T. Lin and C. S. Lee, Neural Fuzzy Systems, Prentice Hall Publishing, 1995

62. Course Code: EE406 **Course Title:** Electromagnetic Compatibility **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To develop the knowledge of EM theory and EMI measurements.

CO-2: To analyse the methods of shielding and grounding.

CO-3: To understand the concept of EMI filters.

CO-4: To understand EMC regulations and standards.

Syllabus:

Review of EM theory. EMI from apparatus and circuits. EMI measurements. Shielding and grounding. EMI filters. Electrostatic discharge. EMC standards.

References:

- H. W. Ott, Noise Reduction Techniques in Electronic Systems.
- V. Prasad Kodali, Engineering Electromagnetic Compatibility, S. Chand & Co.

63. Course Code: EE408 **Course Title:** Solid State Drives **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of different control techniques of DC/AC drive.

CO-2: Ability to select suitable special electrical drive and apply appropriate control method for the application.

Syllabus:

Separately excited dc motor drive: Operation and performance, single-phase fully controlled converter, operation on dual converter. Chopper drive: operation and performance calculation on class A, class C, and class E choppers. Induction motor drive: Stator voltage control with constant supply frequency, qualitative comparison of converter combinations, slip energy recovery scheme, VSI fed induction motor, CSI fed induction motor, synchronous motor drive, VSI drive, brushless excitation, true synchronous and self-controlled operation, performance with PMSM and synchronous reluctance motor.

References:

- S. B. Dewan, G. R. Slemon, A. Straughen, Power Semiconductor Drives, John Wiley and Sons, 1984.
- W. Shepherd, L. N. Halley, D. T. W. Liang, Power Electronics and Motor Control, 2nd Edition, Cambridge University Press, 1998.
- Vedam Subrahmanyam, Electric Drives – Concepts and Applications, TMH, 1994.
- G. K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall, 1989.

64. Course Code: EE410 **Course Title:** Power System Protection **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Understand the details of power system protection and computer aided protection.

CO-2: Understand the working of various power system protection schemes and power apparatus protection

CO-3: Knowledge in recent trends in power apparatus protection methodology, and application of soft computing methods in numeric relaying

Syllabus:

Introduction to power system protection, Review of conventional power system protection schemes, power apparatus protection: viz. transformer, motor, generator, bus bar, transmission and distribution line protection schemes, Introduction to computer aided protection, numeric relay hardware design, digital protection algorithms, recent trends in power apparatus protection methodology, concepts of adaptive relaying and application of soft computing methods in numeric relaying.

References:

- Warrington, Protective Relays – Their theory and practice, Volumes. I, II, and III, Chapman and Hall.
- Arun G. Phadke, J. S. Thorpe, Computer Relaying for Power Systems, Research Studies Press.
- Gerhard Ziegler, Numerical Distance Protection: Principles and Applications.
- T. Johns, S. K. Salman, Digital Protection for Power Systems, IEE, 1995.
- M. S. Sachdev (Coordinator), IEEE Tutorial Course on Advancement in Microprocessor-based Protection and Communication, IEEE, 1979

65. Course Code: EE411 **Course Title:** Operation Of Power Systems Under Deregulation **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand the operation and control of power systems under deregulated environment.

CO-2: To understand different pricing mechanism of electric energy and trading of power under deregulated environment

CO-3: To analyze the performance of restructured power system with FACTS controllers and distributed generation.

CO-4: Knowledge of IT applications in restructured markets.

Syllabus:

Fundamentals of deregulation, restructuring models and trading arrangements, different models of deregulation, operation and control, wheeling charges and pricing, Role of FACTS controllers and distributed generation in restructured environment, developments in India, IT applications in restructured markets.

References:

- K. Bhattacharya, M. H J Bollen and J. E Daalder, "Operation of Restructured Power Systems", Kluwer Academic Publisher, USA, 2001.
- L. Philipson and H. L. Willis, "Understanding Electric Utilities and Deregulation", Marcel Dekkar Inc. 1999.
- M. Shahidehpour and M. Alomoush, "Restructured Electrical Power Systems, Operation, Trading and Volatility", Marcel Dekkar Inc. 2001.
- Steven Stoft, "Power System Economics: Designing Markets for Eligibility". John Wiley & Sons, 2002

66. Course Code: EE412 **Course Title:** Random Signal Processing **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand the mathematical description and representation of random signals.

CO-2: To analyse and understand the response of linear and discrete time systems.

CO-3: To acquire knowledge about discrete Kalman filter and basic estimation theory.

CO-4: To acquire knowledge to use state space modelling concepts.

Syllabus:

Random signal processing: Review of probability and random variables, Mathematical description of random signals, response of linear systems to random inputs, Wiener filtering, basic estimation theory, discrete Kalman filter, state space modeling and simulation, nonlinear estimation.

References:

- Athanasios Papoulis, Probability, Random variables, and Stochastic Processes, McGraw-Hill, 1991.
- R. G. Brown, P. Y. C. Hwang, Introduction to Random Signals and Applied Kalman Filtering, John Wiley and Sons, 1997.
- P. Sage, James L. Melsa, Estimation Theory with Applications to Communications and Control, McGraw-Hill, 1971.

67. Course Code: EE414 **Course Title:** Non-Conventional Energy Systems **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Apprise the environmental impacts of conventional energy sources and the need of renewable energy.

CO2: Gain knowledge on the process involved in various renewable energy generations.

CO3: Suggest and configure the various hybrid systems.

Syllabus:

Solar energy, wind energy, chemical energy sources. Energy from the ocean and tides. MHD generation, thermo electric power. Geothermal energy. Energy from bio-mass.

References:

- G. D. Rai, Non-conventional Energy Sources. P.
- S. Sukhatme, Solar Energy.

68. Course Code: EE418 **Course Title:** Advanced Power Electronics **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of different power devices and their characteristics

CO-2: Knowledge of power conditioning system using different converters and inverters

CO-3: Understanding soft-switching process against hard-switching in High-frequency operation

CO-4: Be able to design DC-DC resonant power converters

Syllabus:

Power devices, design of inductors, transformers, selection of core, design of capacitors, selection of capacitors for different applications. AC to DC converters, multilevel inverters, DC to DC converters, hard switch converters, design and analysis, isolated converters, resonant converters.

References:

- Ned Mohan, Undeland, Robbins, Power Electronics.
- M. H. Rashid, Power Electronic Circuits – Devices and Applications.

69. Course Code: EE420 **Course Title:** Power System Dynamics **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To gain knowledge of detailed modelling of synchronous machines

CO-2: To carry-out stability studies of large power system

CO-3: To perform large-signal stability analysis of power system under faulted conditions

Syllabus:

Power system component modeling for dynamic studies: Synchronous generator modeling, exciter and turbine modeling, load modeling. System stability analysis: Angle stability (small signal and large signal), voltage stability, frequency stability. K. R. Padiyar, Power System Stability and Control, Interline, 1996.

References:

- Prabha Kundur, Power System Stability and Control, McGraw-Hill, 1994.

70. Course Code: EE422 Course Title: Principles of Switchgear and Protection (L-T-P) Credits: (3-1-0)4

Course Outcomes (COs):

CO-1: Student should be able to appreciate the role of switchgear and protective equipment.

CO-2: Student should be able to identify the types of switchgear and protective equipment.

CO-3: Student should be able to identify the important specification of the equipment.

CO-4: Student has the relevant vocabulary in the field of switchgear and protection.

CO-5: Student when enters electrical power industry will be able to read line-diagrams and schemes.

CO-6: Student should be able to appreciate the safety rules regulations for safe operation of power systems.

CO-7: Student will learn to learn having introduced the relevant Indian(IS)/IEC/IEEE standards.

Syllabus:

Fuses and switches, methods of earthing, Circuit breakers. circuit breaker ratings, auto reclosure. Protective relaying, fundamental characteristics. Relay classifications, differential protection schemes. Transformer protection. Buchholtz relay. Alternator protection: Negative phase sequence relay, loss of field protection. Line protection: Over current relays and schemes, distance relays and schemes, carrier current relaying. Induction motor protection: Abnormal operating conditions. Solid state relays: Comparators, duality between phase and amplitude comparators. Realization of directional, Ohm, reactance, impedance and Mho characteristics using the general characteristic equation, static distance relays. Computer aided relaying: Introduction to microcomputer based relays, General functional diagram of microcomputer-based relays.

References:

- Ravindranath, Chander, Power System Protection and Switchgear, Wiley Eastern, 1994.
- C. L. Wadhwa, Electrical Power Systems, 2nd Edition, PHI, 1993.
- Arun G. Phadke, S H Horowitz, Power System Relaying, 2nd Edition, John Wiley, 1995.
- Badriram, D. N. Vishwakarma, Power System Protection and Switchgear, TMH, 1995.

71. Course Code: EE423 Course Title: Switchgear and Protection Laboratory (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: Student should be able to appreciate the role and type of switches, switches gear and protective equipment.

CO-2: Student should be able to identify the types of switchgear and protective equipment.

CO-3: Student should be able to identify the important specification of the equipment.

CO-4: Student has the relevant vocabulary in the field of switchgear and protection.

CO-5: Student when enters electrical power industry will be able to read line-diagrams and understand the protective schemes.

CO-6: Student will learn to learn having introduced the relevant Indian/IEC/IEEE standards.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE422. The course will have experiments related to: Fuses and fuse elements. Study of Induction motor starters. Study of MCCB and ELCB. Circuit breakers and their control circuits. Over current, Earth fault, Differential protection, Phase unbalance, Under frequency, Thermal and other relays and protective schemes

72. Course Code: EE427 **Course Title:** Computer Networks **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of layered architecture of computer networks.

CO-2: Exposure to computer network and its applications.

Syllabus:

Introduction, physical layer, data link, media Access, network layer, transport layer, ATM, applications.

References:

- Andrew S. Tanenbaum, Computer Networks, Pearson Education.

73. Course Code: EE428 **Course Title:** THE ARM Core: Architecture and Programming **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand the internal architecture of the ARM processor and be able to write Assembly code

CO-2: To gain knowledge of design and working of ARM processor.

Syllabus:

The ARM design philosophy, ARM processor fundamentals – registers, current program status register, pipeline, exceptions, interrupts and the vector table, core extensions, architecture revisions, ARM processor families. The ARM instruction set: Data processing instructions, branch instructions, load-store instructions, software interrupt instructions, program status register instructions, conditional execution. The THUMB instruction set, THUMB register usage, ARM THUMB interworking. Writing assembly code, profiling and cycle counting, instruction scheduling, register allocation, looping constructs, bit manipulation, efficient switches, unaligned data handling. GNU assembler. Optimized primitives, exception and interrupt handling. Rudimentary aspects of embedded operating systems.

References:

- David Seal (Ed.), ARM Architecture Reference Manual, 2nd Edition, Addison-Wesley, 2001.

- Steve Furber, ARM Sytem-on-Chip Architecture, 2nd Edition, Addison-Wesley, 2000.
- Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide, Elsevier, 2004.
- ARM Limited, ARM v7-M Architecture Application Level Reference Manual, ARM Limited, 2006.

74. Course Code: EE430 **Course Title:** Robot Dynamics and Control **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Knowledge in various robot structures and their workspace

CO-2: Knowledge and skills associated with robot control.

CO-3: Skills to perform kinematics analysis of robot systems.

CO-4: knowledge of the singularity issues associated with the operation of robotic systems.

Syllabus:

Introduction to robotics: History of robots, components and structures of robots, rigid motion and homogeneous transformations: representing position and rotation, rotational transformations, composition of rotations, parameterization of rotation, homogeneous transformations, Forward Kinematics, Inverse kinematics, velocity kinematics- the manipulator Jacobian, Dynamics: Euler-Lagrange equations, generalized expression for potential and kinetic energy, properties of robot dynamic equations, equation of motion, Independent joint control: set point tracking using classical PID control, force control, feedback linearization control. Computer vision: geometry of image formation, camera calibration, segmentation by thresholding, connected components, position and orientation of the object. Introduction to path planning and collision avoidance.

References:

- M. W. Spong, S. Hutchinson and M. Vidyasagar, Robot Dynamics and Control by, John Wiley & Sons, 2008.
- Craig, John J. Introduction to robotics: mechanics and control. Vol. 3. Upper Saddle River: Pearson Prentice Hall, 2005.
- Sciavicco L, Siciliano B. Modelling and control of robot manipulators. Springer Science & Business Media; 2012

75. Course Code: EE432 **Course Title:** Machine Learning **(L-T-P) Credits:** (3-1-2) 5

Course Outcomes (COs):

CO-1: Identify or Categorise the machine learning problems into Classification, Clustering, Prediction, Association, and Prescription.

CO-2: List different Machine Learning Models and Compare them for - implementation, performance, and ease of communication.

CO-3: Apply descriptive analytics and obtain insights from the model data; detect relations and plan further course of study.

CO-4: Apply analytics and recommend alternative solutions to a problem.

CO-5: Adopt of *Open Sources and Free softwares* for machine learning applications.

Syllabus:

Introduction, linear classification, perceptron update rule; Perceptron convergence, generalization; Maximum margin classification; Classification errors, regularization, logistic regression; Linear regression, estimator bias and variance, active learning; Active learning, non-linear predictions, kernals; Support vector machine (SVM) and kernels, kernel optimization; Model selection, Model selection criteria; Description length, feature selection; Combining classifiers, boosting, Boosting, margin, and complexity; Margin and generalization, mixture models, Mixtures and the expectation maximization (EM) algorithm, regularization, clustering; Spectral clustering, Markov models, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Probabilistic inference. Simulation exercises covering the theory.

References:

- Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995.
- Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000.
- MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University, Press, 2003.
- Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997.
- T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
- Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

76. Course Code: EE439 **Course Title:** Advanced Power Electronics Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: To gain knowledge of working of modern power converters through experimental studies

CO-2: To have hands on experience of using advanced instruments e.g., DSO, Current and voltage probes etc.

Syllabus:

Laboratory exercises and assignments to provide additional support to EE418

77. **Course Code:** EE443 **Course Title:** Mathematical Morphology And Applications To Signal Processing **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understand the mathematical morphology concepts and morphological operators

CO-2: Ability to use theoretical concepts, nonlinear signal operators, and algorithms aiming at extracting, from images or other geometrical objects, information related to their shape and size

CO-3: Knowledge on recent developments in theoretical and practical aspects of mathematical morphology and its applications to image and signal processing.

Syllabus:

Introduction to Mathematical morphology: Minkowski addition and Minkowski subtraction, Introduction to the lattice theory, Structuring elements and its decomposition. Fundamental Morphological Operators: Erosion, Dilation, Opening, Closing, Binary vs Greyscale Morphological operations. Hit-or-Miss transform, Skeletons, Morphological reconstructions, Thinning, Thickening: Hit-or -Miss transformation, Skeletonization, Coding of binary image Via Skeletonization, Skeletonization by influence Zones(SKIZ), Weighted SKIZ, Medial Axis Transformation(MAT), Skeletonization Via Euclidean Distance Transformation, Partial Skeletons, Morphological Shape Decomposition(MSD), Morphology Thinning, Thinking, pruning, MSD Vs SKIZ. Morphological Filtering and Segmentation: Multi- scale Morphological Transformation, Top – Hat and Bottom Hat Transformation, Alternative Sequential filtering, Segmentation, Watershed Segmentation, Connected Operators for Segmentation, Hierarchical Segmentation Vs Watersheds, Markers, Hierarchical Segmentation, Geodesic active contours. Geodesic Transformation and Metrics: Geodesic Morphology, Graph – Based Morphology. Euclidean Metric, Geodesic Distance (Shortest path), Dilation distance, Hausdorff Dilation and Erosion distances. Applications of Mathematical Morphology.

References:

- J. Serra, Image Analysis and Mathematical Morphology, Academic Press London, 1982
- J. Serra, Image Analysis and Mathematical Morphology: Theoretical Advance, Academic Press, 1988

78. **Course Code:** EE445 **Course Title:** Power System Simulation Laboratory-I **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: To gain knowledge of Time-domain analysis of SMIB system through MATLAB simulations

CO-2: To analyse multimachine systems through digital simulations

Syllabus:

Time–domain simulation of SMIB and multi-machine power systems in MATLAB®/SIMULINK™ to provide additional support to EE420.

79. Course Code: EE454 **Course Title:** Flexible AC Transmission Systems **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand transmission system performance**.**

CO-2: Application of various compensation techniques using active and passive FACTS devices.

CO-3: To analyze of stability performance of the system with FACTS devices.

Syllabus:

Transmission system performance, compensation approaches, static var systems, VSI based FACTS controllers –STATCOM, UPFC, TCSC, TCPAR, TCBR. Applications: Transient stability improvement. Introduction to custom power.

References:

- K. R. Padiyar, Power System Dynamics, Stability and Control, 2nd Edition, B. S. Publishers.
- Prabha Kundur, Power System Stability and Control, McGraw-Hill EPRI Power System Engineering Series, 1994.
- Narain G. Hingorani, Laszlo Gyugyi, Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 2001.

80. Course Code: EE456 **Course Title:** High-Voltage Engineering **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: To understand the principles of high voltage (AC, DC and impulse voltages) generation and measurements.

CO-2: To understand breakdown of HV insulation (solid, liquid and gas dielectrics)

CO-3: To understand partial discharge.

Syllabus:

Electric breakdown in solid, liquid and gas dielectrics. Generation of high AC, DC and impulse voltages. Impulse current generators. Methods of measuring high AC, DC and impulse voltages and current. Partial discharge.

References:

- E. Kuffel, Zengal, High Voltage Engineering.
- D. Kind, An Introduction to High Voltage Experimental Techniques.

- Kamaraju, Naidu, High Voltage Engineering.
- C. L. Wadhwa, High Voltage Engineering.

81. Course Code: EE458 **Course Title:** Photovoltaics and Applications **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Knowledge on the solar radiation, measurements and characteristics of solar PV cell.

CO-2: Knowledge on different semiconductor materials used in PV cell and its characteristics.

CO3: Understand various power electronic converters used for standalone and grid connected PV systems with and without energy storage.

Syllabus:

Overview of PV systems, relevance and adaptology, economics and efficiency, insolation and its measurement, types of cells. Elements of solar cell operation, light absorption and carrier generation in semiconductors, conversion efficiency and factors affecting it, Processing techniques. Concentrators, stand-alone inverters, grid operation, issue of energy storage, general applications, large PV power systems, rural power supply systems, Issues in developing countries, unconventional cell systems. conversion.

References:

- Chenming Hu, R. M. White, Solar cells- From Basic to Advanced Systems, McGraw-Hill.

82. Course Code: EE464 **Course Title:** Power Generation and Economics **(L-T-P) Credits:** (3-1-0) 4

Course Outcomes (COs):

CO-1: Determine the significance of various components of the power generation plants.

CO-2: Plan an appropriate scheduling of electric power to satisfy the demand constraint.

CO-3: Appreciate the different types of tariff, consumers and different types of power generation plants.

Syllabus:

Hydro, thermal and nuclear power plants. Electrical equipments in generating stations. Load forecasting and sharing. Economic operation of power systems. Economic choice of transformers and electric motors.

References:

- M. V. Deshpande, Elements of Power Station Design.
- G.P. Chalotra, Electrical Engineering Economics.

- S. Domkundwar, S. C. Arora, A Course in Power Plant Engineering.

83. Course Code: EE466 **Course Title:** Utilization of Electrical Energy **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to understand and analyse the practical application of electrical power.

CO-2: Knowledge of key feature of electrical traction and associated control of motors

Syllabus:

Electric Traction: Requirements of an ideal traction system, requirements of ideal traction motors, comparison and control of traction motors, mechanics of train movement, tractive effort for acceleration,train resistance, gradient, coefficient of adhesion, speed time curves, specific energy consumption. Electric heating: methods of heat transfer, resistance heating, design of heating element, induction heating, eddy current heating, dielectric heating. Electric welding: resistance welding, arc welding. Electrolytic processes: Faraday's laws of electrolysis, Calculation of current required and related definitions, Factors governing the character of deposits, preparation of work for electroplating, electro-extraction. Illumination : Laws of illumination, lighting calculations, polar curves, Rousseau's construction.

References:

- Partab, Art and Science of Utilization of Electrical Energy.

84. Course Code: EE467 **Course Title:** Industrial Electrical systems **(L-T-P) Credits:** (3-0-0)3

Course Outcomes (COs):

CO-1: Acquire knowledge about the electrical systems used in various industries.

CO-2: To understand the operation and control of electrical systems used in industries.

CO-3: To analyse the operation of the electrical systems with industry-specific case studies.

CO-4: Ability to choose suitable electrical systems in different situations of industrial needs.

Syllabus:

Overview of electrical systems in manufacturing, chemical, metallurgical, process industries, electric traction, electric heating, electric welding, electroplating, illumination and case studies.

References:

- Partab, Art and Science of Utilization of Electrical Energy.
- E. O. Taylor, Utilization of Electric Energy.
- C. L Wadhwa, Generation, Distribution and Utilization of Electrical Energy.

85. Course Code: EE468 **Course Title:** Advanced Electric Drives **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability for the dynamic modelling the electrical machines.

CO-2: Ability to perform dynamic operation of electrical drives

Syllabus:

Electric Drives: DC drives, modelling, analysis and simulation. Space phasors, modelling of brushless DC motor, modelling of induction motor, vector control of brushless DC motor. Induction motor drive: V/f control, vector control of induction motor, DT control of induction motor drives.

References:

- W. Leonhard, Electric Drives, Springer Verlag.
- B. K. Bose, Power Electronics and AC Drives.

86. Course Code: EE469 **Course Title:** Renewable Energy Systems **(L-T-P) Credits:** (3-0-0) 3

Course Outcomes (COs):

CO-1: Apprise the environmental impacts of conventional energy sources and the need of renewable energy.

CO2: Gain knowledge on the process involved in various renewable energy generations.

CO3: Suggest and configure the various hybrid systems.

Syllabus:

Concept of renewable energy, design and implementation aspects of renewable energy systems employing solar energy, wind energy, chemical energy sources. Energy from the ocean and tides. MHD generation, thermo electric power. Geothermal energy. Energy from bio-mass.

References:

- G. D. Rai, Non-conventional Energy Sources. P.
- S. Sukhatme, Solar Energy.

87. Course Code: EE470 **Course Title:** Computational Techniques for Large System Analysis **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Able to develop analytical and computational skills required for power system problems.
CO-2: Able to utilize various numerical techniques for the solution of power system problems.

CO-3: Able to develop generalized algorithms & verify them logically on standardized test systems.
CO-4: Able to use matrix and power system properties to simplify & speedy evaluation of the analysis.

Syllabus:

Solution of linear system of equations, solution of nonlinear system of equations, sparsity techniques, numerical integration techniques: explicit methods, implicit methods, fixed step methods, variable step methods, stability and accuracy-analysis of numerical methods, numerical calculation of eigenvalues, EMTP simulation techniques.

References:

- Steven C. Chapra, R. P. Canale, Numerical Techniques for Engineers, TMH, 2000.
- Mariessa Crow, Computer Techniques for Large Electric Power Systems, CRC Press, 2003.

88. Course Code: EE471 Course Title: Power System Simulation Laboratory II (L-T-P) Credits: (0-0-3)2

Course Outcomes (COs):

CO-1: Exposure to programming skills required for power system analysis.

CO-2: Able to develop programs for simulation studies of power system analysis using Matlab.

Syllabus:

Developing computer programs related to some of the techniques/methods and its application to power system analysis to provide additional support to EE470.

89. Course Code: EE472 Course Title: Insulation and Testing Engineering (L-T-P) Credits: (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of properties and characteristics of various insulation types: solids, liquids, gases and vacuum

CO-2: To understand methods of measurements of insulation resistance, PD, etc.

CO-3: Understand testing of various electric power components

Syllabus:

Introduction, review of test sources and measurement associated with insulation studies. Insulation types: solids, liquids, gases and vacuum, properties and characteristics. Dielectric strength and permittivity, methods of measurements, theories of breakdown. Testing of transformer oil, Schering bridges for tan-delta measurement. Measurement of insulation resistance of solids: Bulk and surface. PD measurements. Testing of cables IR, PI, step test, tan delta, PD. Treeing tracking. Radio interference measurements, RI and RIV. Testing of insulators, power transformers, Impulse testing, testing of rotating machines. Accelerated ageing tests and life estimation. Testing of surge diverters, bushings, insulators. Testing of rubber mats. Testing of Gas Insulated Substations.

References:

- Kamaraju, Naidu, High Voltage Engineering.
- Kuffel, Zeangle, High Voltage Engineering.
- Relevant Indian standards and Technical papers.

90. Course Code: EE476 **Course Title:** Optimisation Techniques **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Fundamental knowledge of Linear Programming, Dynamic Programming and Non -linear programming problems.

CO-2: Understanding of classical optimization techniques and numerical methods of optimization.

Syllabus:

Linear Programming: Simplex method and extensions. Network models: Shortest path, maximum flow and minimum cost problems. Dynamic programming: resource allocation, production scheduling and equipment replacement problem. Non -linear programming: selected unconstrained and constrained non-linear programming algorithms like quasi Newton reduced gradient and gradient projection methods. Penalty function methods, quadratic programming.

References:

- Lueneburger, Linear and Non linear Programming, McGraw-Hill.
- Fletcher, Optimization techniques, John Wiley and Sons.

91. Course Code: EE478 **Course Title:** An introduction to the INTEL IA-32 Architecture **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Understand the hardware architecture and instruction set of IA – 32.

CO-2: Understand the execution environment and memory organization in multicore technology.

CO-3: Acquire knowledge about the concept of paging and virtual memory.

CO-4: Write well – modularised computer programs with IA -32 in GNU/Linux environment.

Syllabus:

A brief history of the IA-32 architecture, the Intel P6 family of processors – Intel Pentium®, Xeon®, Pentium® M, Pentium® Extreme, Core™ Duo and Core™ Solo. SIMD instructions, Hyper-threading technology, Multicore technology. Basic execution environment, memory organization, paging and virtual memory, address calculations in 64- bit mode. Basic program execution registers, instruction pointer, operand addressing, memory operands, segmentation, I/O port addressing. Data types.

Implementation of the IEEE 754 floating point format. Overview of FP exceptions and FP exception handling. General purpose instructions, FPU instructions, MMX instructions, SSE instructions, SSE2 and SSE3 extensions. Programming with GP instructions, Programming with the x87 FPU. Programming the IA-32 in the GNU/Linux environment.

References:

- Intel Corporation, IA-32 Intel Architecture Software Developer's Manual, Volume1:Basic Architecture, Intel Corporation, 2006.
- Intel Corporation, IA- 32 Intel Architecture Software Developer's Manual, Volume 2A: Instruction Set Reference, A-M, Intel Corporation, 2006.
- Intel Corporation, IA-32 Intel Architecture Software Developer's Manual, Volume 2B: Instruction Set Reference, N-Z, Intel Corporation, 2006.

92. Course Code: EE489 **Course Title: Advanced Electrical Drives Laboratory** **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: Ability to apply the concept of V/f control, vector control and direct torque control through Simulations

CO-2: Ability to verify the advanced concepts through prototype models

Syllabus:

Laboratory exercises and assignments to provide additional support to EE468.

93. Course Code: EE491 **Course Title:** Insulation and Testing Engineering Laboratory **(L-T-P) Credits:** (0-0-3)2

Course Outcomes (COs):

CO-1: To gain knowledge of testing Cables, insulators etc. under the application of high voltage

CO-2: To understand problems of EMI etc. in power systems

Syllabus:

Laboratory exercises and assignments to provide additional support to EE472.

94. Course Code: EE500 **Course Title:** System Analysis in Discrete Time **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of Linear difference equations and its solutions.

CO-2: Ability to discretize the differential equations and do its modeling and analysis.

Syllabus:

The calculus of finite differences; Operators and their properties; Inverse operators. Difference equations and their solutions. Linear difference equations with constant coefficients, general and particular solutions. Discretization of differential equations. Modeling and analysis of LTI lumped-parameter systems in discrete time.

References:

- Kelley W. G. , Peterson A. C. , " Difference Equations: An Introduction with Applications", 2nd Edition, Elsevier, 2001.
- Goldberg S. , "Introduction to Difference Equations", 2nd Edition, Dover, 1986.
- Elaydi S. , "An Introduction to Difference Equations", 3rd Edition, Springer International Edition, 2008.

95. Course Code: EE501 **Course Title:** Analysis of Nonlinear Circuits **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of different nonlinear circuits and network.

CO-2: Understanding of various design principles and methods of practical nonlinear circuits.

Syllabus:

Nonlinear circuit elements, v-i characteristics, energy and power considerations. Time-varying elements, multiterminal elements. Resistive nonlinear circuits, graphical analysis. Dynamic nonlinear networks, autonomous and non-autonomous networks. Analysis of memristive circuits.

References:

Chua L. O. , "Introduction to Nonlinear Network Theory", McGraw-Hill, 1969.

Chua L. O. , Desoer C. A. , Kuh E. S. , "Linear and Nonlinear Circuits", McGraw-Hill, 1987.

96. Course Code: EE449& EE 499 **Course Title:** Major Projects I & II **(L-T-P) Credits:** (0-1-3)3

Course Outcomes (COs):

CO-1: learn to analyse a problem independently and in team.

CO-2: Ability to design and manage task for real world problem

UG Programme: B. Tech. Minor Degree in Electrical and Electronics Engineering

Course Details

1. Course Code: EE230 **Course Title:** Electric Circuits **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Ability to apply network reduction techniques and network theorems

CO-2: To be able to model dynamical systems using state-space equations

CO-3: To obtain time-domain solutions using vector-matrix approach

CO-4: To get an insight about three-phase systems and magnetic circuit calculations.

Syllabus:

Review of network geometry and network reduction techniques. Network theorems. Network variables, identification of the number of degrees of freedom, the concept of order of a system, establishing the equilibrium equations, network modeling based on energy-indicating (state) variables in the standard form, natural frequencies and natural response of a network. Introduction to system functions, inclusion of forcing functions, solution methodology to obtain complete solution in the time-domain - the vector-matrix approach. Analysis of network response (in the timedomain) for mathematically describable excitations. Solution strategy for periodic excitations. The phenomenon of resonance and its mathematical analysis. Sinusoidal steady state analysis. . Introduction to to three-phase systems. Magnetic circuit calculations.

References:

- Ernst A. Guillemin, Introductory Circuit Theory, John Wiley and Sons, 1953.
- Charles A. Desoer, Ernest S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969.
- Russell M. Kerchner, George F. Corcoran, Alternating Current Circuits, 4 th Edition, Wiley Eastern, 1960

2. Course Code: EE261 **Course Title:** Basic Electric Machines **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of construction and working principle of electrical machines.

CO-2: Realize the requirement of electrical machines in electric power and other applications.

CO-3: To understand steady-state modeling of electrical machines

CO-4: Ability to apply models of electrical machines to analyse their steady-state characteristics.

Syllabus:

Review of power network structures, principle of energy conversion. Transformers: Principle, construction, development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers. Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, speed control, effect of single-phasing. Single-phase induction motor. DC Machines : Construction, classification, emf and torque equations, characteristics of DC motors, speed control, brushless DC motor. Stepper motor: Construction, principle of operation and control. Synchronous machines: Construction, prime-mover and excitation control systems. Steady state characteristics, voltage regulation calculations by synchronous impedance method. Synchronous motors and condensors, Permanent magnet synchronous motors, Switched reluctance motors.

References:

- M. G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.

3. Course Code: EE310 **Course Title:** Electric Power System **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of power system networks and single-line diagram representation

CO-2: Ability to carry out per-unit computations

CO-3: To be able to model different types of transmission lines

CO-3: Ability to solve power flow problems and stability related problems.

Syllabus:

Electrical energy sources, power network structure and its components. per unit representation, single-line diagram representation. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions. Power system operation and control: State of operation of a power system, voltage and frequency control mechanisms, power generation, Introduction to tariff structure. Transmission lines: Design, modeling and performance analysis. Cables, insulators, grounding and safety. System modeling. Steady state analysis: power flow –NR Method. balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria.

References:

- Olle I. Elgerd, Electric Energy Systems Theory – An Introduction, TMH, 1982.
- Arthur R. Bergen, and Vijay Vittal, Power System Analysis, Pearson Education Asia, 2001.
- J. Nagrath, D. P. Kothari, Power System Engineering, TMH.
- John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994

4. Course Code: EE370 **Course Title:** Electrical and Electronics Measuring Instruments and Techniques **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of measurement, measuring instruments and different terminologies related to measurement.

CO-2: Ability to apply the complete knowledge of various electrical and electronics instruments/transducers to measure the physical quantities in the field of engineering and technology

CO-3: Capable of using oscilloscopes to visualize waveforms and measurements.

Syllabus:

Review of units, standards, dimensional analysis. Measurement basics: accuracy, precision, significant figures, errors (quantification and analysis), calibration. Measuring instruments: Analog and digital, Concept of true rms, DVM, multi-meter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, frequency, impedance, harmonics, power, power factor, and energy. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of R, L, C and applications. Indicating, recording and integrating type of instruments. Measurement of non-electrical quantities (Displacement, Pressure, Temperature, Strain, Acoustic, flow and Photo measurement etc.) and instrumentation. Basics of transducers.

References:

- Golding and Widdis, 'Electrical Measurements and Measuring Instruments', Wheeler Publishing House, New Delhi 1979.
- K. Sawhney, 'A Course in Electrical Measurement and Measuring Instruments', Dhanpat Rai and Sons, New Delhi 2007
- M. B. Stout, 'Basic Electrical Measurements'
- C. T. Baldwin, 'Fundamentals of Electrical Measurement'
- B. S. Sonde, 'Transducers and Display Systems', Published by McGraw-Hill Inc. ,US, 1978.

5. Course Code: EE415 **Course Title:** Power Electronics in Power Control **(L-T-P) Credits:** (3-1-0)4

Course Outcomes (COs):

CO-1: Knowledge of power electronic devices, reactive elements and their characteristics.

CO-2: Knowledge of various power electronic converters.

CO-3: Ability to perform simulations of power electronic converters.

Syllabus:

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs. Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications. Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

References:

- Ned Mohan,Undeland, Robbins, Power Electronics, 3rd edition, John Wiley.
- M. H. Rashid, Power Electronics, 3rd edition, PHI.
- P C Sen, Power Electronics, Tata McGraw-Hill Publishing Company Ltd.
- Bimal K. Bose, Modern power electronics and ac drives,PHI.
- L. Umanand, Power Electronics, Wiley India Pvt Ltd.

*****THE END*****