MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT OF ELECTRICAL ENGINEERING

Scheme & Syllabus
of
B. Tech. (Electrical Engineering)

Curriculum Structure of B. Tech. (Electrical Engineering)

Semester III

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
EET-201	Network Theory	3-1-0	4	4
EET-203	Electrical Measurement & Instrumentation	3-1-0	4	4
EET-205	Electrical Machines-I	3-1-0	4	4
EET-207	Electronic Devices & Circuits	3-1-0	4	4
EET-209	Power Station Practices	3-1-0	4	4
EEP-211	Circuit & Measurement Lab	0-0-2	2	1
EEP-213	Electronic Devices & Circuit Lab	0-0-2	2	1
EEP-215	Electrical Software & Simulation Lab	0-0-2	2	1
	Total		26	23

Semester IV

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
EET-202	Analysis & Design of Digital Logic Circuits	3-1-0	4	4
EET-204	Electromagnetic Field Theory	3-1-0	4	4
EET-206	Electrical Machines-II	3-1-0	4	4
EET-208	Network, Systems and Signals	3-1-0	4	4
EET-210	Integrated Electronics	3-1-0	4	4
EET-212	Electrical Power Transmission Systems	3-1-0	4	4
EEP-214	Electrical Machine Lab-I	0-0-2	2	1
EEP-216	Instrumentation Lab	0-0-2	2	1
	Total		28	26

Semester V

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
EET-301	Power System Switchgear and Protection	3-1-0	4	4
EET-303	Power Electronics	3-1-0	4	4
EET-305	Microprocessors	3-1-0	4	4
EET-307	Control System Engineering	3-1-0	4	4
EET-309	Principles of Communication Engineering	3-1-0	4	4
EEP-311	Electrical Machine Lab II	0-0-3	3	2
EEP-313	Power System Lab	0-0-2	2	1
EEP-315	Digital Electronics & Microprocessor Lab	0-0-2	2	1
		Total	27	24

Semester VI

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
EET-302	Operation and Control of Power Systems	3-1-0	4	4
EET-304	Electric Drives & Control	3-1-0	4	4
EET-306	Digital Signal Processing	3-1-0	4	4
EET-308	Modern Control Theory & Design Technique	3-1-0	4	4
EET-310	Power System Restructuring, Deregulation and Economics	3-1-0	4	4
EEP-312	Power Electronics Lab	0-0-2	2	1
EEP-314	Power System & Electrical Design Lab	0-0-3	3	2
EEP-316	Control System Lab.	0-0-2	2	1
		Total	27	24

Semester VII

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
EES-401	Training Seminar	0-0-3	3	2
	Open Elective-I	3-1-0	4	4
	Open Elective-II	3-1-0	4	4
	Program Elective-I	3-1-0	4	4
	Program Elective-II	3-1-0	4	4
	Program Elective-III	3-1-0	4	4
		Total	23	22

Program Electives for VII Semester

S. No.	Course Code	Title of the Course
1.	EET-403	High Voltage Engineering
2.	EET-405	Electrical Machine Design
3.	EET-407	Utilization of Electrical Power
4.	EET-409	Computer Architecture and Organization
5.	EET-411	Advanced Electrical Machines
6.	EET-413	Microcontroller Based System Design
7.	EET-415	Renewable Energy Sources
8.	EET-417	Power System Planning and Reliability
9.	EET-419	Computer Aided Power System Analysis
10.	EET-421	Advance Engineering Mathematics
11.	EET-423	Power System Operation in Restructured Markets
12.	EET-425	Intelligent Systems & Control
13.	EET-427	Advanced Course in Power Electronics
14.	EET-429	Optimal Control Theory & Applications
15.	EET-431	Electric Vehicle Technologies

Semester VIII

Course Code	Title of the Course	L-T-P Structure	Contact Hours	Credit
	Basic Management	3-1-0	4	4
	Open Elective-III	3-1-0	4	4
	Open Elective-IV	3-1-0	4	4
	Advance Elective - I	3-1-0	4	4
	Advance Elective - II	3-1-0	4	4
EED-402	Major Project	0-0-12	12	12
EES-404	Seminar	0-0-3	3	2
	Total		35	34

Advance Electives for VIII Semester

S. No.	Course Code	Title of the Course
1.	EET-404	Advance Power Transmission
2.	EET-406	Advance Power System Dynamics
3.	EET-408	Energy Conservation and Management
4.	EET-410	Advanced Control Systems
5.	EET-412	Advances in Power Transmission & Distribution
6.	EET-414	Power System Stability
7.	EET-416	Applications of Power Electronics in Power Systems
8.	EET-418	Modelling & Simulation of Power Electronic Systems
9.	EET-420	Modelling and Analysis of Electrical Machines

EET-201 Network Theory Credit: 4 (3-1-0)

Node and mesh analysis. Network theorems. Analysis of three-phase circuits. Non-sinusoidal periodic waves. Trigonometric and exponential forms of Fourier series, waveform symmetry, response to linear networks. Analysis of magnetically coupled circuits. Transient analysis in time and frequency domains. Special signal waveforms. Network graph, duality. Resonance. Generalized two port networks, two port parameters, interconnection, image impedance.

Text / References

1. M. E. Van Valkenburg: Network Analysis, III Ed.., Prentice Hall of India.
2. W. H. Hayt, J. E. Kemmerly and S. M. Durbin: Engineering Circuit Analysis, VII Ed., McGraw Hill.
3. Joseph Edminister: Electrical Circuits, III Ed., Schaum's Outline, Tata McGraw Hill.
4. Lawrence P. Huelsma: Basic Circuit Theory, III Ed., Prentice Hall of India.
5. D. Roy Choudhury: Network & Systems, Wiley Eastern Ltd.
6. De Carlo and Lin, Linear Circuit Analysis, Oxford Press

EET-203 Electrical Measurements and Instrumentation Credit: 4 (3-1-0)

Standards of measurement and theory of errors, measurement of power, energy, frequency, voltage, power factor using analogue and electronic meters, measurement of low, medium and high resistances, magnetic measurements, Q-meter, spectrum and wave analyser, cathode ray oscilloscope, generalized treatment of A.C. bridges, instrument transformers, ratio and phase angle errors, display devices and recorders, transducers, measurement of non-electrical quantities.

Text / References

1. A.K. Sawhney, “Electrical & Electronic Measurement & Instruments”, Dhanpat Rai & Sons, India.
2. W.D. Cooper, “Electronic Instrument and Measurement Technique”, Prentice Hall International, India.
3. E.O. Doebelin and D. N. Manik, “Measurement systems application and design”, TMH, New Delhi.
4. E.W. Golding & F.C. Widdis, “Electrical Measurement and Measuring Instruments”, A.W. Wheeler and Co. Pvt. Ltd. India.
5. Forest K. Harries, “Electrical Measurement”, Wiley Eastern Pvt. Ltd. India.
6. M.B. Stout, “Basic Electrical Measurement” Prentice hall of India, India.
7. Oliver and Cage, “Electronic Measurements and Instrumentation”, TMH.

EET-205 Electrical Machines-I Credit: 4 (3-1-0)

Dc Machines: Basic principles of electromagnetic energy conversion, Construction, operation, characteristics, performance, of dc generators and motors, .testing of dc machines, applications,

Transformers: Construction, working principle, equivalent circuit, voltage regulation, efficiency, parallel operation and testing of single-phase transformers, Auto-transformers, Connections and harmonics in three-phase transformers, Tertiary winding, heating characteristics of distribution transformer, dry type transformer.

Text / References

1. Irving L. Kosow: Electric Machinery and Transformers, Prentice Hall India Publication.
2. A.E. Fitzgerald, Charles Kingsley: Electrical Machines, IV Edition, Mc-Graw Hill.
3. A.S. Langsdorf : Theory of Alternating Current Machinery, Tata Mc-Graw Hill.
4. I.J. Nagrath, D.P. Kothari : Electrical Machines, Tata McGraw Hill.
5. M. G. Say: The Performance and Design of Alternating Current Machines, III Edition, CBS Publishers & Distributers

EET-207 Electronic Devices & Circuits Credit: 4 (3-1-0)

Bipolar Junction Transistor configurations and characteristics, Typical transistor-junction voltage values, Phototransistor, Transistor at low frequencies, Analysis of a transistor amplifier circuit using h-parameters, Miller's theorem, Cascaded transistor amplifiers, High input resistance transistor circuits. BJT biasing circuits, Bias stability and bias compensation, Thermal runaway, Junction Field Effect Transistor characteristics, FET biasing circuits, FET small-signal model, MOSFET characteristics, Low-frequency FET amplifiers, Classification of multistage amplifiers, Distortion in amplifiers, Frequency response of amplifiers.

Text / References

1. Millman & Halkias: Integrated Electronics, TMH.
2. Boylestad & Nashelsky: Electronic Devices & Circuit Theory, PHI.
3. D.L. Schilling & C.Belove: Electronic Circuits, McGraw-Hill.
4. Floyd: Electronic Devices, Pearson.
5. Electronic Devices & Circuits, Schaum's Outlines Series, McGraw-Hill.

EET-209 Power Station Practices Credit: 4 (3-1-0)

Bulk energy generation-Conventional generation of electrical energy using thermal, hydro, nuclear and diesel based power plants, concept of cogeneration, non-conventional sources of energy, load and load curves, load forecasting, electricity tariffs, power factor improvement, power plant economics, economic operation of steam plants, electrical equipment of power stations and sub-stations, and their general arrangement, standards of supply systems, power generation scenario in India.

Text / References

1. Gupta B. R., Generation of Electrical Energy, Fourth Edition, S. Chand & Company Ltd.
2. M. V. Deshpande, Elements of Electrical Power station Design, PHI India
3. Wadhwa C. L., Generation, Distribution and Utilization of Electrical Energy, Wiley Eastern Ltd.
4. Nagrath & Kothari, Power System Engineering, PHI India

EET-202 Analysis and Design of Digital Logic Circuits Credit: 4 (3-1-0)

Data Representation; Boolean Algebra and Logic Gates; Simplification of Boolean Functions: Karnaugh -Map Quine -Macluskey Minimisation Technique, Determination and Selection of Prime-Implicants;

Digital Integrated Circuits: Bipolar Transistor Characteristics, RTL and DTL Circuits, TTL Logic, Emitter Coupled Logic (ECL), MOS and CMOS Logic Families, Realization of Logic Gates in RTL, DTL, TTL, ECL and CMOS;

Combinational Logic: Design Procedure, Adders and Subtractors, Code Conversion, Multilevel NAND and NOR Circuits, Binary Parallel Adder & Subtractor, BCD Adder & Subtractor, Magnitude Comparator, Encoder, Decoder, Multiplexer, Demultiplexer, Read-only Memory (ROM) and Programmable Logic Array (PLA).

Sequential Logic: Flip-flops. Triggering of Flip-flops. Analysis of Clocked Sequential Circuits, State Reduction and Assignment, Flip-flop Excitation Tables, Design Procedures and Design with State Equations.

Registers, Counters and Memory Unit: Registers -Buffer Register, Shift Registers, Serial and Parallel Loading of Data. Counters -Ripple Counters, Modulus Counter, Ring Counter, Synchronous Counter, UP and DOWN Counters, Timing Sequences. Memory Unit, Memory Cell, Random Access Memory and Memory organisation.

Text / References

1. M. Morris Mano: Digital Logic and Computer Design, PHI Publication.
2. Morris Mano: Computer System Architecture, PHI Publication.
3. ZVI Kohavi: Switching Theory and Finite Automata Theory, Tata McGraw Hill.
4. Herbert Taub: Digital Integrated Electronics, McGraw Hill Inc. Donald Schilling
5. Malvino: Digital Computer Electronics, Tata McGraw-Hill.
6. Williar I. Fletcher: An Engineering Approach to Digital Design, Prentice Hall of India

EET-204 Electromagnetic Field Theory Credit: 4(3-1-0)

Electrostatics: Electric field due to various charge configurations. Electric potential and displacement vector. Gauss's law. Poisson's and Laplace's equation and their solution. Uniqueness theorem. Continuity equation. Electrostatic energy. Field determination by method of images. Boundary conditions.

Magnetostatics: Biot-Savart's law. Ampere's law. Magnetic vector potential. Energy stored in magnetic field. Interaction of moving charge and current with magnetic field. Boundary conditions. Analogy between electric and magnetic fields.

Time Varying Fields: Faraday's law. Displacement current and equation of continuity. Maxwell's equations. Uniform plane wave in free space. Dielectrics and conditions. Skin effect, Reflection of a plane wave at normal incidence. Standing wave ratio. Poynting vector and power considerations.

Radiation: Retarded potentials and concepts of radiation. Alternating current element and power radiated by Hertzian dipole. Radiation resistance.

Text / References

1. Matthew N.O. Sadiku: Elements of Electromagnetics, Oxford Univ. Press.
2. Darid J. Griffiths: Introduction to Electromagnetics, Prentice- Hall of India.
3. William H. Hayt Jr: Engineering Electromagnetics, Tata McGraw Hill.
4. John D. Kraus: Electromagnetics, McGraw-Hill Inc.
5. P. V. Gupta: Introductory Course in Electromagnetic Fields, Dhanpat Rai & Sons.

EET-206 Electrical Machines-II Credit: 4 (3-1-0)

Induction machines: Construction, working principle, equivalent circuit, torque-slip curves, performance calculation, starting, speed control of three-phase induction motors. Cogging and Crawling. High torque-cage motors. Induction generator.

Single-phase induction motors: double revolving field theory, torque slip characteristics

Synchronous Machines: Construction, basic principles and theory of cylindrical and salient-pole synchronous machines. Equivalent circuit, voltage regulation, operational characteristics, parallel operation, synchronizing, hunting. Working principle, starting, operation and applications of synchronous motors.

Text / References

1. Irving L. Kosow: Electric Machinery and Transformers, Prentice Hall India Publication.
2. A.E. Fitzgerald, Charles Kingsley: Electrical Machines, IV Edition, Mc-Graw Hill.
3. A.S. Langsdorf: Theory of Alternating Current Machinery, Tata Mc-Graw Hill.
4. I. J. Nagrath, D.P. Kothari: Electrical Machines, Tata McGraw Hill.
5. M. G. Say: The Performance and Design of Alternating Current Machines, III Edition, CBS Publishers & Distributers

EET-208 Network, Systems and Signals Credit: 4(3-1-0)

Complex frequency, network functions. Elements of Passive Network Synthesis. Synthesis of RL, LC, RC and RLC driving point functions Minimum functions and their synthesis (Brunn's and Bott & Dufffin's method). Theory of reactive filters, Constant –k, m-derived, composite and lattice filters, half section terminations. Introduction to RC active filters: Basic specifications of active filters, frequency response of Bi-quadratic filters.

Introduction to Signals and Systems, System Properties, Convolution of Signals, Linear Shift Invariant Systems and their Properties. Introduction to Transforms, Fourier Series and Fourier Transform, Convergence of Fourier Transform, Properties of Fourier Transform. Sampling Theorem, Sampling/Reconstruction of Signals, Realistic Sampling, Aliasing, Relation between continuous and discrete time systems

Suggested References:

1. M. E. Van Valkenburg: Network Synthesis, Prentice Hall of India.
2. W. H. Hayt, J. E. Kemmerly and S. M. Durbin: Engineering Circuit Analysis, VII Ed., McGraw Hill.
3. Joseph Edminister: Electrical Circuits, III Ed., Schaum's Outline, Tata McGraw Hill.
4. Lawrence P. Huelsma: Basic Circuit Theory, III Ed., Prentice Hall of India.
5. D. Roy Choudhury: Network & Systems, Wiley Estern Ltd.
6. A. V. Oppenheim and A. S. Willsky: Signals and Systems, II Ed., Prentice Hall of India.
7. Simon Haykin: Signals and Systems, II Ed., John Wiley and Sons.
8. L. T bruton: RC Active Networks, PHI
9. F. F. Kuo: Network Analysis and Synthesis, John Wiley, 2nd Edition
10. Behrouz Peikari, Fundamentals of Network Analysis and Synthesis, Jaico Publication, 2006

EET-210 Integrated Electronics Credit: 4 (3-1-0)

Operational Amplifiers: Introduction, Differential amplifier, Transition delay, DC & AC analysis of dual input balanced output differential amplifier configuration, Inverting and non-inverting inputs, Common mode rejection ratio (CMRR) , Op-Amp symbol & circuit model, the ideal op-amp, equivalent circuit of an Op-Amp, open loop OP-Amp configuration and Op-Amp parameters.

Operational Amplifier Applications: Introduction Op-Amp differential amplifier, adder, subtractor, integrator, differentiator circuit using OP-Amp, voltage to current and current to voltage converter, Instrumentation amplifier, log and anti-log amplifier, the peaking amplifier, sample and hold circuit.

Comparator, Limiters and Converters: Introduction, Basic comparator, Zero Crossing detector, Schmitt trigger, Voltage Limiters, Clippers and Clampers, Voltage to frequency and frequency to voltage converters.

Active Filters and Oscillators: Introduction, First order and second order low pass filters, First order and second order high pass filters, Band pass filter, Principle of oscillator, Phase shift oscillator, Triangular wave generator, Saw-tooth wave generator

Voltage Regulators: Introduction, Parameters for voltage regulators and voltage references, basic configuration of voltage regulators and references, Shunt regulator& Series pass regulator.

Text /References

1. Sedra / Smith, Micro Electronic Circuits Oxford University Press, 2004.
2. Schilling and Belove, Electronic Circuits, 3rd Edition, TMH, 2002.
3. Robert L. Boylestad and Louis Nasheresky, Electronic Devices and Circuit Theory, 9th Edition, Pearson Education / PHI, 2002.
4. David A. Bell, Solid State Pulse Circuits, Prentice Hall of India, 1992.
5. Millman and Halkias. C., Integrated Electronics, TMH, 1991.

EET-212 Electrical Power Transmission Systems Credit: 4 (3-1-0)

General layout of transmission and distribution system, Insulators, method of improving string efficiency, Mechanical characteristics of transmission lines, Sag templates. Transmission line parameters Overhead lines & Underground Cables: parameters calculations.

Performance of Transmission Lines: Modeling of transmission lines, Steady-state analysis, Generalized ABCD line constants.

Symmetrical faults analysis using Z impedance matrix. Symmetrical components, Sequence network and sequence impedance, Unsymmetrical fault analysis,

Grounding: Types and methods

Text / References

1. Elements of Power System Analysis, William D. Stevenson Jr., Mc-Graw Hills
2. Power System Analysis, Hadi Saadat, Mc-Graw Hills
3. Modern Power System Analysis, D.P. Kothari and I.J. Nagrath, Tata McGraw Hill,

EET-301 Power System Switchgear and Protection Credit: 4 (3-1-0)

Introduction: Protective relays preliminaries, Functional characteristics of relays, Primary and backup protection, Classification of relays, Types of Electromagnetic relays.

Types, characteristics and settings of over current relays, operation and characteristics and connection of Directional over current relays. Operation and characteristics of Differential relays and percentage differential relays.

Distance relays: Types, characteristics and operation. Connection of distance relays for line and earth fault protection.

Protection of Transmission Line; Over current protection of radial feeder, parallel feeder and ring mains using time and current grading, Distance protection. Effect of arcing and power swings on the performance different distance relays **Carrier Current Protection of Transmission Lines:** Basic apparatus used for power line carrier system. Principle of operation of directional comparison and phase comparison carrier protection. Carrier assisted distance protection.

Protection of Synchronous Generators and Transformers: Faults in stator winding of alternators, differential protection. Effect of resistance in the star point earthing.Single and multiple ground faults on the rotor protection against excitation failure and primemover failure.Negative sequence protection.Differential protection of generator transformer unit.Differential protection of 3-phase transformers, effect of magnetizing inrush currents and methods for minimizing the effects., CT connections. Buchholtz protection

Bus-Bar Protection: Frame leakage and circulating current protection.

Current and Voltage Transformers : Steady state performance of CT, equivalent circuit, phasor diagram and accuracy. Steady state performance of VT, equivalent circuit, phasor diagram. Coupling Capacitor Voltage Transformer and its analysis.

Circuit Breakers: Classification of switchgear and fields of application and relative merits. Theories of current interruption, energy balance and recovery rate theories. Practical systems of arc quenching in oil circuit breakers. Construction and operation of bulk oil, air blast and minimum oil circuit breakers. Recent trends in H.V. circuit breakers, use of sulphur Hexafluoride, vacuum circuit breakers. Rating of circuit breakers.Testing of circuit breakers.

Basics of Sub-station automation, GIS switchyard.

Texts / References:

1. B. Ravindranath and M. Chander: Power System Protection and Switchgear, Wiley Eastern Ltd.
2. Power System Protection & Switchgear By B. Ram, McGraw Hill
3. Power System Protection- Static Relays By T.S.M. Rao Tata McGraw Hill
4. Power System Protection By Patra Basu & Choudhary, Oxford & IBH
5. Protective Relay, Their Theory & Practices Vol. 1 By A.R.C. Warrington, Chapman & Hall UK
6. Badri Ram and DN Vishwakarma: Power system Protection and Switchgear, Tata McGraw Hill Publishing Company Limited.
7. A.G.Phadke:Power System Relaying, Kohn Wiley & Sons, 2008.

EET-303 Power Electronics Credit: 4 (3-1-0)

Introduction to Solid State Power Devices & Operation: SCR, Power Transistor, MOSFET, IGBT, GTO, Classification of SCR triggering methods, Design and operation of triggering circuits, Commutation methods, Pulse transfer and isolation scheme, Protection of power devices, Series and parallel operation of SCRs.

Phase Controlled Converters: Single phase uncontrolled, half-controlled and fully controlled converters. Three-phase half-controlled and full controlled bridge converters.

Choppers: Different schemes and circuit configurations. Buck, Boost, Buck-boost and Flyback converter.

Regulators: Single-phase A.C. Regulators-different circuit configuration and their operation.

Inverters: Single-phase and Three-phase bridge converter operating as line-commutated voltage source inverters, force commutated inverters, Pulse width modulated inverters with IGBTs/MOSFETs, Gate driving Circuit, Dead-time, Design of Snubber Circuit, Current source inverter.

Cycloconverters: Three-phase to single-phase and three-phase to three-phase configurations.

Text / References

1. Joseph Vithayathil, Power Electronics: Principles and Applications, Tata McGraw-Hill Education.
2. Mohammad H. Rashid: Power Electronics Circuits, Devices and Applications, Prentice Hall of India Pvt. Ltd.
3. B. R. Pelly: Thyristor Phase Controlled Converters and Cycloconverters, John Willey & Sons.
4. Murphy & Turnbull: Power Electric Control of AC Motors, Pergawen Press.
5. Power Electronics by P. S. Bimbhra, Khanna Publications.
6. Power Electronics, Converters, Applications and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, Wiley

EET-305 Microprocessors Credit: 4 (3-1-0)

Architecture of 8085 microprocessor, instruction set. Programming using assembly language (8085) for looping, decision making, counting, indexing, searching. Interrupts and subroutine. Timing. Interfacing memory, input/output and other peripherals e.g., 8255, 8253/54, 8259 and 8257, data (A/D and D/A) converters. Introduction to 8086/88 processors and 8051 microcontroller.

Text / References

1. Ramesh S. Gaonkar, 'Microprocessor Architecture, Programming and Application with 8085', Fourth Edition, Penram International Publishing (India)
2. B. Ram, 'Fundamentals of Microprocessor and Microcomputers', Fifth Edition, Dhanpat Rai Publications (P) Ltd.
3. K. Ray and K. M. Bhurchandi, 'Advanced Microprocessors and Peripherals: Architecture, Programming and Interface', Tata McGraw-Hill Publishing Company Limited
4. Kenneth J. Ayala, 'The 8051 Microcontroller: Architecture, Programming and Applications', Second Edition, Thomson Delmar Learning, Penram International Publishing (India).

EET-307 Control System Engineering Credit: 4 (3-1-0)

Open loop and closed loop control systems. Signals and elements used in control system. Applications of open loop and closed loop systems. Advantages and disadvantages of an open loop and closed loop control systems. Servomechanism.

Modelling of mechanical, electrical and electro-mechanical systems by differential equations. Analogy between electrical and mechanical systems. Transfer function and its properties. Determination of transfer function by use of block diagram reduction technique and signal flow graph method.

Time response analysis of first order and second order system: Standard test signals. Transient response analysis and its performance indices. Effect of adding zero and pole on the control system. Design considerations for higher-order systems. Steady state error and error constants.

Absolute stability and relative stability. Conditions for stability. Routh's stability criterion. Relative stability analysis. The Root locus concepts. Construction of Root loci. Root contours. Stability analysis by use of root locus method.

Frequency domain method: Correlation between time and frequency response. Polar plot and Bode plot. Determine the Gain and Phase margin. Nyquist stability criterion. Determine the relative stability using Nyquist criterion. M and N Loci.

Text/ References

1. I.J. Nagrath & M. Gopal: Control Systems Engineering, III Edition, NAI Pub.
2. Katshuhiko Ogata: Modern Control Engineering, III Edition, PHI.
3. Banjamin C. Kuo: Automatic Control Systems, VII Edition, PHI.

EET-309 Principles of Communication Engineering Credit: 4 (3-1-0)

Introduction to Communication systems; Signal Distortion over a communication channel; Signal Power and Power Spectral Density.

Modulation and detection in analogue systems; Amplitude Modulation; Super heterodyne AM receiver; Angle Modulation; FM receiver.

Pulse Code Modulation; Sampling and data reconstructions; Quantization & coding; Sampling Theorem; Differential Pulse Code Modulation; Delta Modulation

Time division and frequency division multiplexing; Equalization;

Introduction to Satellite Communication; Cellular Communication; Optical Fiber communication, Basic information theory.

Text / References

1. Lathi B.P, Modern Digital and Analog Communication Systems, 3rd Ed, Oxford University Press, 2005.
2. H. Taub, D. L. Schilling and Gautam Saha, Principles of Communication Systems, 3rd ed, TMH, 2008.
3. Haykin, Communication Systems, 4th Ed, John Wiley & Sons, 2004.

EET-302 Operation and Control of Power Systems Credit: 4 (3-1-0)

Load Flow Analysis and Static Load flow equation, Bus admittance matrix. Bus classification. Gauss Siedel, Newton Raphson and fast decoupled Load flow methods.

Economic Operation of Power Systems: Distribution of loads between units within a plant. Distribution of loads between plants, Transmission loss equation, Classical Economic dispatch with losses. Optimal unit commitment problems and their solutions.

Voltage and Load Frequency Control: Introduction to control of active and reactive power flow, control of voltage, Excitation systems. Introduction to Load Frequency Control and Automatic generation control, Single area and modelling of AGC, Concept of multi area AGC.

Power System Stability: Concepts, steady state and transient stability, swing equations, equal area criterion. Solution of Swing Equation, Transient stability analysis of multi-machine systems

Text / References

1. O.E. Elgard: Electric Energy Systems Theory. TMH Publishing Company.
2. Nagarth & Kothari: Power System Engineering, TMH Publishing Company.
3. B.R. Gupta: Power System Analysis and Design, Wheeler Publishing.
4. C.L. Wadhawa: Electrical Power Systems, Wiley Eastern Limited.
5. Chatraborty, Soni, Gupta & Bhatnagar: Power System Engineering. Dhanpat Rai & Co.
6. Elements of Power System Analysis, William D. Stevenson Jr., Mc-Graw Hills

EET-304 Electric Drives & Control Credit: 4 (3-1-0)

Review: Principle of starting & speed control of DC and AC motors.

Definitions and Characteristics: Definition of electric drives, advantages, important features, electrical characteristics, motor ratings, control features, cost and types of motor available.

Multi-quadrant operation and Modeling: Plugging, Regenerative and dynamic braking of DC and AC motors, Multi-quadrant characteristic, Modeling of DC and AC motors.

Solid State Control: Control of DC drives – Phase angle and chopper control, Steady-state performance, Converter rating and closed-loop control.

Control of Induction Motor Drives: Stator voltage control, rotor resistance control, variable frequency control, scalar control, vector control, controlled current operation, closed loop operation, comparison with other methods of control.

Estimation of Drive Motor Rating: Selection of motor power capacity for continuous duty at constant load and variable loads, Selection of motor capacity for short time and intermittent periodic duty.

Text / References

1. G. K. Dubey, "Fundamental of Electric Drives", 2nd Ed., Narosa Publishing House.
2. S. K. Pillai, "A first course in electric drives", 2nd Ed., New Age International Private Ltd.
3. P. C. Sen, "Thyristor DC Drives", John Willey & Sons.
4. J. M. D. Murphy & F. G. Turnbull, "Power Electric Control of AC Motors", Pergamon Press.
5. B. K. Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.
6. R. Krishnan, "Electric motor drives: modeling, analysis, and control", Prentice Hall PTR, 2001.

EET-306 Digital Signal Processing Credit: 4 (3-1-0)

Introduction to DSP, Digital Systems- Characterization, Description and Testing.

FIR and IIR: Recursive and Non Recursive, Discrete Fourier Transform, Z Transform.

Discrete Time Systems in Frequency Domain.

Simple Digital Filters, Digital Processing of Continuous Time Signals.

Analog Filter Design, Digital Filter Structure, Synthesis and Design.

Text / References

1. Prokias John G, Digital Signal Processing, 3rd Ed ,Prentice Hall of India,2007.
2. Oppenheim, Schafer, and Buck, Discrete-Time Signal Processing, 3rd Ed, Prentice Hall of India, 2009.
3. Mitra Sanjiv K, Digital Signal Processing, 4th Ed, Mc-Graw Hill, 2013.

EET-308 Modern Control Theory & Design Technique Credit: 4 (3-1-0)

Introduction, Comparison of modern control theory with conventional control theory, Definition of state, state variable and state vector, State Variable representation, conversion of state variable models to transfer functions, conversion of transfer function into canonical variable.

Eigen values, eigen vector and diagonalisation, State transition matrix and its properties, methods for evaluation of state transition matrix, solution of state equations, controllability and observability.

Description of common non – linearities in control system, introduction of digital control system and its advantages and disadvantages.

Compensator networks using passive electrical components and operational amplifiers, various types of controllers and their effects on performance of control system.

Control system design by root locus method, use of digital computer as a compensator device and configuration of basic computer control scheme.

Texts/ References

1. D.G. Schultz and J.L. Melso: State Functions and Linear Control Systems.
2. K. Ogata: Modern Control Engineering, PHI.
3. B.C. Kuo: Automatic Control Systems, PHI.

EET-310 Power System Restructuring, Deregulation and Economics

Credit: 4 (3-1-0)

HVDC Transmission System: Introduction to HVDC transmission, Mono polar, Bi polar and Homo polar HVDC systems, Economic, technical and reliability comparison Of HVAC and HVDC transmission system. Status of HVDC transmission in India

Flexible AC Transmission System: Fundamentals of ac power transmission, transmission problems and needs, Mechanism of active and reactive power flow control, basic FACTS controllers with application and principles of operation. Recent developments.

Distribution System: Components and Types. Representation of components, Distribution system automation, Introduction to wide area measurement, monitoring and control. PMU Applications.

BIS and IIS Standards of components of power systems

Restructuring of Power Industry: Fundamentals of restructured system,. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model. Components of restructured systems, Functions and responsibilities, Open Access Transmission Systems

Fundamentals of Deregulation: Need for deregulation, Components of Deregulation, Technical, economic & regulatory issues involved in deregulation of power industry.

Transmission Network Pricing: Models of transmission pricing, Different transmission services, Network cost evaluation methods, Cost allocation methods, Wheeling transactions.

Power Sector in India: Introduction to various institutions in Indian Power sector: Ministry of Power, Planning Commission, CEA, central utilities, state utilities, PGCIL, PFC, state and central governments, REC, ERCs, traders, SO, LDCs, Power Exchanges, and their roles.

Text / References

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd, England, 2001.
2. D. S. Kirschen and G. Strbac, Fundamentals of Power System Economics, John Wiley & Sons, 2004.
3. Geoffrey Rothwell, Tomas Gomez (Eds.), "Electricity Economics Regulation and Deregulation", IEEE Press Power Engineering Series, John Wiley & Sons, 2003.
   Stoft, S., Power System Economics, Wiley Interscience, 2002

PROGRAMME ELECTIVES

EET-403 High Voltage Engineering Credit: 4 (3-1-0)

Breakdown in Gases: Mechanism of breakdown in gases; various related ionization processes, Townsends and Streamer theories, Paschen's Law. Breakdown in non-uniform fields. Effect of waveshape of impressed voltage on the breakdown strength. Breakdown of sphere gap and rod gap.

Breakdown in Liquid and Solids: Mechanism of breakdown in liquids; suspended particles, suspended water, cavitation and bubble and electronic breakdown theories. Mechanisms of breakdown of solids; intrinsic, electro- mechanical, erosion, surface, thermal and streamer. Relation between electric strength of solids and log time, intrinsic breakdown strength.

Impulse Generator: Specifications of an impulse voltage wave, standard impulse. Impulse generator (Mars circuit) circuit, working, earthing and tripping. Technique to observe wavefront on CRO.

Generation of High Voltage: Method of generation of power frequency high voltages-cascade transformers and resonance methods. Generation of high voltage-D.C. voltage multiplier circuit, Electrostatic generators, voltage stabilization. Tesla coil.

Measurement of High Voltage: Potential dividers; resistive, capacitive and mixed dividers for high voltage. Sphere gap; construction, mounting, effect of nearby earthed objects, effect of humidity and atmospheric conditions, effect of irradiation and of polarity. Electrostatic voltmeter; principle and classification. Constructional details of an absolute electrostatic voltmeter. Oscilloscope and their application in high voltage measurements.

High Voltage Testing: Measurement of insulation resistance of cables. Wet and dry flashover tests of insu1ators. Testing of insulators in simulated pollution conditions. Testing of transformers. Measurement of breakdown strength of oil. Basic techniques of non-destructive testing of insulators; measurement of loss angle and partial discharge measurement techniques.

Text/ References

1. C.L. Wadhwa, 'High Voltage Engineering' New Age International Publishers, 1994.
2. M.S. Naidu, V. Kamaraju, 'High Voltage Engineering' Tata McGraw Hill, 1995.
3. D.V Razevig, 'High Voltage Engineering' Khanna Publishers, 1990

EET-405 Electrical Machine Design Credit: 4 (3-1-0)

General: Factors and limitations in design. Output coefficients, classification of magnetic materials and allowable flux densities. Calculation of magnetic circuits, magnetizing current, coils for given temperatures. Real and apparent flux densities. Tapered teeth. Carter's coefficient, leakage fluxes reactances. Classifications of insulation materials and the temperature ranges.

Armature Winding: General features of armature windings, single layer, double layer and commutator windings, integral and fractional slot windings, winding factors. Harmonics, eddy current losses in conductors.

Heating, Cooling and Ventilation: Heat dissipation, heat flow, Heating cooling curves. Heating cooling cycles, estimation of maximum temperature rise, cooling media. Quantity of cooling media, Types of enclosures. Ratings, heat dissipation. Methods of ventilation.

Design of Machines: Application of above design principles for the design of Power Transformers and Synchronous Machines.

Texts / References

1. A.K. Sawhney: A Course in Electrical Machine Design, Dhanpat Rai & Co.
2. R.K. Agarwal: Principles of Electrical Machine Design, S.K. Kataria & Sons.
3. M. G. Say: Design and Performance of A.C. Machines, CPS Publishers.

EET- 407 Utilization of Electrical Power Credit: 4 (3-1-0)

Electric Heating, Welding: Different methods of electric heating. Principle of high frequency induction and di-electric heating. Construction, operation, performance and applications of arc furnace and induction furnaces, Microwave heating.

Classification of Electric Welding: Electric Arc welding. Electric supply for arc welding, welding transformers. Resistance welding.

Electric Drives: Characteristics of load. Review of starting and running characteristics of ac and dc industrial motors. Relative study of efficiency, power factor, size and costs. Starting, speed control of motors. Electric braking- Plugging, Rheostatic and regenerative braking. Behaviour of motor during starting, acceleration, braking and reversing operations. Speed-time relations. Determination of motor rating for intermittent loads. Drives for machine tools, lifts, cranes, paper mills, printing machinery, rolling mills etc.

Electric Traction: Systems of electric traction, power supply systems for track-electrification. Comparison and application of different systems.

Traction Methods: Types of service, speed time and speed distance curves, average and schedule speed. Tractive effort. Estimation of power and energy requirements: specific energy consumption. Mechanics of train movement. Coefficient of adhesion, adhesive and effective weight.

Traction Motor Control: DC and AC traction motors, special requirements of selection of type, speed, torque and current characteristics. Various methods of starting and speed control of DC and AC drives used in traction. Series parallel starting. Shunt and bridge transition. Drum and contactor type controllers. Metadyne control. Multiple unit control and master controllers.

Means of Supplying Power and Train Lighting: Overhead equipment, current collection. System of train lighting, special requirements, methods of obtaining unidirectional polarity and constant output voltage.

Texts /References

1. H. Pratab: Utilisation of Electric Power
2. H. Pratab: Modern Electric Traction
3. M.V. Suryanarayana: Utilisation of Electric Power & Electric Traction.

EET-409 Computer Architecture and Organization Credit: 4 (3-1-0)

Register Transfer and Micro-operations: Register transfer, bus and memory transfer, arithmetic micro-operations, logic micro-operations, shift micro-operations. Basic Computer Organization: Instruction code, computer registers, memory reference instructions, input-output and interrupts

Central Processing Unit: General register organization, stack organization, instruction format, addressing modes, data transfer & manipulation.

Computer Arithmetic: Addition, subtraction, multiplication and division operation for fixed point signed magnitude data and 2's complement data, floating point arithmetic operations, decimal arithmetic operations.

Input-Output Architecture: Peripheral devices, input-output interface, asynchronous data transfer, direct memory access. Priority Interrupt - Daisy Chain Priority Interrupt and Parallel Priority Interrupt.

Memory and Storage: Processor v/s memory speed, memory hierarchy, main memory, associative memory, auxiliary memory, cache memory, virtual memory management hardware.

Texts /References

1. M. Morris Mano: Computer System Architecture, III Edition, PHI.
2. M. Morris Mono: Digital Logic and Computer Design, PHI.
3. John P. Hayes: Computer Architecture and Organisation, McGraw Hill, International Editions.
4. V. Carl Hamacher: Computer Organisation, McGraw Hill, International Z.G. Vranesic, S.G. Zaky Editions.

EET -411 Advanced Electrical Machines Credit: 4 (3-1-0)

Synchronous Machines: Transient performance of synchronous machines. Analysis of three phase symmetrical short circuit. Various inductances and time constants of synchronous machines, models for transient analysis. Transient Power/Angle characteristics. Vector diagrams for steady and transient conditions.

Induction Machines: Operation of three phase Induction machines on unbalanced supply voltage, effect of time harmonics in supply voltage, space harmonics in field flux, single phasing. Harmonic synchronous and induction torques. Noise and its reduction.

Special Machines: Qualitative treatment of stepper, hysteresis Linear Induction motors, MEGLEVS. Reluctance and single phase induction motors.

Texts /References

1. E. Fitzgerald, Charles Kingsley and Stephen D Umans: Electric Machinery, McGraw Hill Publication
2. S. Langsdorf: Theory of Alternating Current Machinery, Tata McGraw Hill

EET-413 Microcontroller Based System Design Credit: 4 (3-1-0)

Architecture of 8051 microprocessors, register set, pins and signals, bus organization, memory organization, instruction set. Programming using assembly language (8051) for looping, decision making, counting, indexing, searching, assembler directives. Interrupts, subroutine and Macros. Interfacing with memory. Internal and external addressing. Introduction of ARM series MCUs, C programming for microcontroller, RS232, 485, USB. Application in 7-segment LED display, LCD 16x2, keypad 4x4, UART serial port, microcontroller based protective relays, measurement of electrical quantities, measurement of physical quantities, interfacing with stepper motor, traffic light control.

Text / References

1. Kenneth J. Ayala, 'The 8051 Microcontroller: Architecture, Programming and Applications', Second Edition, Thomson Delmar Lerning, Penram International Publishing (India).
2. Md. Ali Mazidi, Janice Gillispie Mazidi, 'The 8085 Microcontroller and Embedded Systems', Pearson Education Asia.

EET-415 Renewable Energy Sources Credit: 4 (3-1-0)

Introduction to Energy Sources: Energy Sources & their Availability, Renewable Energy Sources & their Prospects.

Solar Energy: Solar Radiation, its computation and measurement. Solar Energy Collectors, Solar Thermal Energy Applications. Storage of Solar Energy, Solar Photovoltaic Technology, Solar cell configurations, voltage developed by solar cell, photo current and load current, solar cell performance, test specifications for photo voltaic systems.

Wind Energy: Basic Principles of Wind Energy Conversion. Wind energy estimation, site selection, components and classification of wind energy conversion systems, their advantages and disadvantages. Wind Machines Generating Systems, Energy Storage, Applications of Wind Energy. Interconnected systems.

Bio Energy: Biomass Conversion Technologies, Biogas generation, Biomass as a source of energy, Applications of Biomass plants, Problems of Biogas plants. Biogas for Biomass, Characteristics of Biogas plants, Thermal Gasification of Biomass.

Other Non-Conventional Energy Sources: Geothermal Energy – Resources and Harnessing Processes and its Applications.

Ocean Energy-Ocean Thermal Energy Conversion (OTEC), Tidal Energy, Wave Energy, Magneto Hydro Dynamic Power Generation- Principles, MHD Systems. Thermo Nuclear fusion energy – Nuclear fusion and Reactions, its requirements.

Grid integration of RES, Energy storage system, Micro-grid

Texts / References

1. Rai G.D: Non-Conventional Energy Sources, Khanna Publishers.
2. Begamudre R. D: Energy Conversion Systems, New Age International Publishers.

EET-417 Power Systems Planning & Reliability Credit: 4 (3-1-0)

Introduction: Objectives of planning, Long and short term planning, Planning of generation, transmission and distribution systems. Least Cost Power Planning, Integration of DSM.

Load Forecasting: Classification and characteristics of loads. Approaches to load forecasting. Forecasting methodology. Short-run and Long run forecasting. Energy forecasting. peak demand forecasting, total forecasting, annual and monthly peak demand forecasting. Electricity Price Forecasting.

Basic Reliability Concepts: General reliability function, exponential distributions, meantime to failure, Markov Chains and processes and their applications, simple series and parallel system models.

Static Generating Capacity Reliability Evaluation: Outage definitions, loss of load probability methods, loss of energy probability method. Frequency and duration methods, load forecasting uncertainty.

Spinning Generating Capacity Reliability Evaluation: Spinning capacity evaluation, load forecast uncertainty.

Transmission System Reliability Evaluation: Average interruption rate method. LOLP method. The frequency and duration method.

Inter-connected Systems Generating Capacity Reliability Evaluation: Introduction, The loss of toad approach. Interconnections benefits.

Reliability evaluation in two and more than two interconnected systems. Interconnection benefits.

Distribution System Reliability Analysis: distribution network reliability, reliability performance.

Text / References

1. Roy Billington, 'Power System Reliability Evaluation', Gordan & Breach Scain Publishers, 1990.
2. Endrenyi, J., 'Reliability modelling in Electric Power System' John Wiley, 1980.
3. Billinton Roy, Allan Ronald, 'Reliability of Power System' Plenum Press, 1996.
4. David Elmakias, 'New Computational Methods in Power System Reliability' Springer-Verlag, 2008.
5. Ali Chowdhury, Don Koval, 'Power Distribution System Reliability: Practical Methods and Applications, Wiley-IEEE Press, 2009.

EET-419 Computer Aided Power System Analysis Credit: 4 (3-1-0)

Three-Phase Networks: Introduction, Three-phase network elements, Three-phase balanced network elements. Transformation Matrices, Three-phase unbalanced network elements, incidence and network matrices for three-phase networks. Algorithm for formation of three-phase bus-impedance matrix. Modification of the three-phase bus impedance matrix for changes in the network.

Short Circuit Studies: Short circuit calculations using Bus Impedance matrix, Short circuit calculations for balanced three- phase network using Bus Impedance matrix, Short circuit calculations using Loop Impedance matrix.

Sensitivity Analysis and Optimal Load Flow: Classification of System variables, Sensitivity Analysis-Sensitivity Matrix, Development of Gx and Gu, Optimal Load Flow, Optimisation Technique, Gradient method. Formulation of Optimal Load-flow Problem and its Solutions, Consideration of Inequality Constraints. Comparison with Classic Economic Dispatch Method.

Security Concept and Contingency Evaluation: Operating States of a Power System, Concept of security Monitoring. Techniques for Contingency Evaluation DC Load Flow, Fast Decoupled Load-flow, Preventive and corrective Measures.

Load Forecasting & State Estimation: Estimation of average, periodic, stochastic components of load, basic idea of state estimation of power system.

Text/ References

1. Computer Techniques In Power System Analysis, M A Pai, Mc-Graw Hills
2. Computer Methods In Power System Analysis, G.W. Stagg & A.H. El-Abiad, Mc-Graw Hills
3. Advanced Power System Analysis And Dynamics, L.P. Singh, Mc-Graw Hills

EET-421 Advance Engineering Mathematics Credit: 4 (3-1-0)

Optimization Fundamentals: Definition; classification of optimization problems; Unconstrained and constrained optimization; optimality conditions. Lagrange Multipliers, formulation of multivariable optimization, Kuhn-Tucker conditions.

Linear Programming: Simplex Method; Duality; Sensitivity methods.

Nonlinear Programming: Powel's method; steepest descent method; conjugates gradient method; Newton's Method GRG method; Sequential quadratic programming; Penalty function method; Augmented Lagrange multiplier method.

Dynamic Programming and Integer Programming: Interior point methods; Karmakar's algorithm; Dual affine; Primal affine; Barrie algorithm.

Meta-Heuristic Optimization: Simulated annealing; Evolutionary Programming; Genetic algorithm and Genetic Engineering; Swarm Optimization and other nature inspired optimization algorithms.

Statistics and Probability: Probability theory , Baye's theorem, Binomial, Poisson and normal distributions, testing of hypothesis, Chi square test- goodness of fit, independence of two variables, Student's t-test, analysis of variance, F-test, correlation and regression, coefficient of correlation, rank correlation ,lines of regression

EET-423 Power System Operation in Restructured Markets Credit: 4 (3-1-0)

Fourier transform Laplace Transform and Z transform techniques

Fundamentals of electricity markets: Market structure and operating mechanisms. Perfect Competition, Oligopolistic Market, Theories of Oligopoly. Market Types- Commodity, Power, Energy, Ancillary Services, Transmission.

Electricity Markets Pricing: Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing.

Electricity Bidding: Generation Auction Markets, Auction Mechanism, Market Equilibrium, Country Practices, Decision making and bidding strategies in generation auction markets. LMP based markets, auction models and price formation, Social welfare maximization, Profit maximization.

Power system operation in restructured markets: Coordinated real time dispatch through balancing mechanism, Imbalance settlement methodologies. Transmission Congestion Management and Methodologies, Congestion Pricing, Effect of congestion on LMPs, Transmission Losses, Limits and Congestion, Country Practices. Available Transfer Capability Evaluation and Methodologies- market splitting, counter-trading. New Unit Commitment-Price based OPF in restructured markets.

Market Power: Definition, Exercise of Market Power, Modelling & Mitigation of Market Power.

Financial Risk Management for Power Markets: Risk and Risk-Hedging Contracts, Forward, Future, Option, Swap and Spot markets, Risk Management Tools, Role of financial Instruments in Market Dispatch and Congestion Management, Options, Contract for differences, Financial Transmission Rights. Arbitrage in Electricity markets.

Ancillary Services: Classifications and definitions, Market for AS, AS management in various markets, country practices, Contingency reserves: Pricing and procurement, Voltage security and reactive power management.

Text / References

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd, England, 2001.
2. M. Shahidehpour, H. Yamin, and L. Zuyi, "Market Operations in Electric Power Systems". New York: Wiley, 2002, p. 191.
3. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured Electric Power Systems: Operation, Trading and Volatility", Marcel Dekker, Inc., 2001
4. D. S. Kirschen and G. Strbac, Fundamentals of power system economics, John Wiley & Sons, 2004
5. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Operation of restructured power systems, Kluwer Academic Publishers, 2001
6. Yong-Hua Song and Xi-Fan Wang (Eds.), "Operation of Market-oriented Power Systems", Spinger-Verlag London Limited, 2003
7. Stoft, S., Power System Economics, Wiley Interscience, 2002.
8. Mohan Munasinghe, "Electric Power Economics", Butterworth & Co. (Publishers) Ltd, 1990.
9. Richard E. Brown, 'Electric Power Distribution Reliability, CRC Press, 2002.

EET-425 Intelligent Systems & Control Credit: 4 (3-1-0)

Introduction: Approaches to intelligent control; Architecture for intelligent control; Symbolic reasoning system; rule-based systems; AI approach; Knowledge representation; Expert systems.

Fuzzy Logic Control System: Motivation and basic definitions; Fuzzy arithmetic and Fuzzy relations; Fuzzy logic modelling and control; Fuzzy knowledge and rule bases; Fuzzy modelling and control schemes for nonlinear systems; Self-organizing fuzzy logic control; Fuzzy logic control for nonlinear time-delay system; Stabilization using fuzzy models; Fuzzy estimators; Adaptive fuzzy control.

ANN Based Controllers and Estimators: Concept of Artificial Neural Networks and its basic mathematical model; McCulloch-Pitts neuron model; simple Perceptron; Adaline and Madaline; Feed-forward Multilayer Perceptron; Learning and Training the neural network; Data Processing: Scaling; Fourier transformation; principal-component analysis and wavelet transformations; Hopfield network; Self-organizing network and Recurrent network; Neural Network based controllers and estimators.

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps; Adjustment of free parameters; Solution of typical control problems using genetic algorithm; Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems; Evolutionary Fuzzy logic controllers.

Case Studies: Identification and control of linear and nonlinear dynamic systems using MATLAB-Neural Network toolbox; Stability analysis of Neural-Network interconnection systems; Implementation of fuzzy logic controller using MATLAB fuzzy-logic toolbox; Stability analysis of fuzzy control systems.

Texts / References

1. Padhy. N.P.: 'Artificial Intelligence and Intelligent System', Oxford University Press.
2. Kosko; B.: 'Neural Networks and Fuzzy Systems', Prentice-Hall of India Pvt. Ltd.
3. Jacek M. Zurada: 'Introduction to Artificial Neural Systems', Jaico Publishing House.
4. Klir G.J. & Folger T.A.: 'Fuzzy sets; uncertainty and Information', Prentice-Hall of India Pvt. Ltd.
5. Zimmerman H.J.: 'Fuzzy set theory-and its Applications', Kluwer Academic Publishers.
6. Driankov; Hellendroon: 'Introduction to Fuzzy Control', Narosa Publishers.
7. Goldberg D.E.: 'Genetic algorithms in Search; Optimization and Machine learning', Addison Wesley.
8. Stanislaw H. Zak: 'Systems and Control' Oxford University Press

EET-427 Advanced Course in Power Electronics Credit: 4 (3-1-0)

Modern Power Semiconductor Devices: Power Transistors, Power MOSFET, IGBT. Comparison of power devices.

PWM Inverters: Single pulse, Multiple Pulse and Sinusoidal PWM, Trapezoidal, Stepped Harmonic Injection and Delta Modulation, Space Vector PWM, Current Hysteresis Controlled PWM. Harmonic elimination schemes. Dead-time, Snubber and Gate Drive circuit. Multilevel Inverters, Basics of Matrix converter.

Resonant Converter: Series Resonant Inverters, Parallel Resonant Inverters, Class E Converter, Two Quadrant ZVS Converter and Resonant DC link Inverter.

Power Supplies: DC Power Supplies: Switched Mode DC Power Supplies, Resonant DC Power Supplies and Bi-Directional DC Power Supplies, AC Power Supplies: Switched Mode AC Power Supplies, Resonant AC Power Supplies and Bi-Directional AC Power Supplies.

Induction Motor Drives: Dynamic modelling of Induction machines, Scalar control (V/f), Vector control, Sensorless vector control, Direct Torque and Flux control.

Introduction to Simulink

Texts / References

1. M. H. Rashid: Power Electronics Circuits, Devices and Applications, Prentice Hall.
2. V. Subrahmanyam: Power Electronics, New Age inc. Publishers, New Delhi.
3. P.C. Sen: Power Electronics Tata McGraw –Hill India.
4. C.W. Lander: Power Electronics II Ed McGraw –Hill.
5. P.S. Bimbhra: Power Electronics II Ed. Khanna Publishers, New Delhi.
6. M.D. Singh and K.B. Kahnchandani: Power Electronics TMH Publishing company, New Delhi
7. R. Krishnan, "Electric motor drives: modeling, analysis, and control", Prentice Hall PTR, 2001.

EET-429 Optimal Control Theory & Applications Credit: 4 (3-1-0)

Fundamentals & Concepts of Optimal Control: State Space Modelling of physical systems, State feedback controller, Design of full and reduced order observers and its applications. Introduction to Optimal Control, Problem statement and examples, formulation performance indices, Calculus of Variations, Definitions and its usefulness in Optimal Control, Conditions for optimum of function and functional.

The Basic Variational Problem: Fixed-End Time and Fixed-End State System, Euler-Lagrange Equation and importance of second variation, discussion on Euler-Lagrange Equation for different cases.

Optimum of Functional: Extrema of Functions and functional with and without constraints, Direct method and Lagrange Multiplier Method for functions and Euler-Lagrange method for functions, Variational Approach to Optimal Control, the Pontryagin Hamiltonian function formulation for variety of situations.

Dynamic Programming: Principle of optimality, backward solution, forward solution, optimal control using dynamic programing, concept of optimal control for discrete-time systems.

Texts / References

1. Linear System Theory and Design by Chi-Tsong Chen; International Fourth Edition (The Oxford Series in Electrical and Computer Engineering) 4th Edition
2. Calculus of Variations and Optimal Control Theory - A Concise Introduction by Daniel Liberzon; Princeton University Press, Princeton and Oxford.
3. Optimal Control Theory - An Introduction by Donald E. Krik; Dover Publications, Inc, Mineola, New York.
4. Optimal Control by Frank L. Lewis, Draguna L. Vrabie and Vassilis L. Syrmos John Wiley & Sons, Inc. Third Edition
5. Optimal Control Systems by D. Subbaram Naidu, Electrical Engineering Series, 1st Edition.

EET-431 Electric Vehicle Technologies Credit: 4 (3-1-0)

Unit I-Components of EV: Introduction, Drive Technology Trends: Electrical Machines, Power Converters, Embedded Batter Sensors, Microcontrollers, Driving Patterns, Drive Design Methodology.

Unit II- EV Technology: EV and PHEV Battery Chargers: Forward/Fly back Converters, Half-Bridge DC–DC Converter, Full-Bridge DC–DC Converter, Power Factor Correction Stage, Bidirectional Battery Chargers, Other Charger Topologies, Inductive Charging, Wireless Charging, V2G and G2V, Bi-directional power flow.

Unit III- Battery Management System: The Goals, Trends in Development of the Batteries, Application Issues of LIBs, Significance of Battery Management Technology, Development of Battery Management Technologies: No Management, Simple Management, Comprehensive Management, Types of Battery, Battery Modelling, BMS Parameter Estimation.

Unit IV- Converter Topology for EV: Types of EV chargers, Half-Bridge Converter with Pulse Width Modulation, Half-Bridge Converter with PWM and Dead-Time Effects, Full-Bridge Converter with Pulse Width Modulation, Three-Phase Pulse Width Modulator with Pulse Centering, Three-Phase Converter with Pulse Width Modulator, Three-Phase Simplified Converter without PWM.

Unit V- Drive and Control Mechanism of EV: Dynamics of Electric and Hybrid Vehicles, Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train Power Flow in HEVs, Torque Coupling and Analysis of Parallel Drive Train, Basic Architecture of Electric Drive Trains, Control System for Electric and Hybrid Electric Vehicles, Rule and Optimization Based Energy Management Strategies (EMS), EMS Based on Deterministic Rules.

Unit VI- Policy: NITI Aayog involvement, FAME scheme and its phases, Rate of deployment of EV off-board chargers, Cost effective policies.

Texts / References

1. Seth Leitman and Bob Brant, Build Your Own Electric Vehicle Mc Grew Hill 2009.
2. Seref Soylu, “Electric Vehicles- The Benefits and Barriers”, Intech Open Access Publisher2011.
3. Rik De Donccker, Duco W. J. Pulle, and Andre` Veltman, Advanced Electric Drives: Analysis, Modeling, Control, Springer 2011.
4. Jiuchun Jiang and Caiping Zhang, Fundamentals and Applications of Lithium Ion Batteries in electric Drive Vehicles, Wiley 2015.
5. Chris M., M. Abul Masrur and David Wenzhong Gao, Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, Wiley 2011.

Advance Elective Course

EET-404 Advance Power Transmission Credit: 4 (3-1-0)

EHV AC Transmission: Need of EHV transmission, standard transmission voltage, electrical and mechanical considerations of EHV lines, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, Features of EHV transmission lines.

HVDC Transmission: DC links, components and configurations, converter station, operation and controls of converters, characteristics, power control, starting and stopping of dc link.

Flexible AC Transmission Systems: Fundamentals of ac power transmission, transmission problems and needs, Mechanism of active and reactive power flow control, basic FACTS controllers with application and principles of operation.

Power Quality: Overview and definition of power quality, Sources of pollution, power quality disturbances, voltage fluctuations, unbalance waveform distortion, power frequency variations, mitigation and control of power quality issues.

Text / References

1. Rakesh Das Begmudre, Extra High Voltage AC Transmission Engineering, Wiley Estern Limited.
2. K.R. Padiyar, HVDC Power Transmission System, Wiley Estern Limited.
3. E.W. Kimbark. EHV-AC and HVDC Transmission Engineering & Practice, Khanna Publishers.
4. Math H. J. Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions, Wiley-IEEE Press.
5. Flexible Ac Transmission Systems, Yong-Hua Song, Allan T. Johns, IEE publication
6. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Narain G. Hingorani, Laszlo Gyugyi

EET-406 Advance Power System Dynamics Credit: 4 (3-1-0)

Dynamic models of synchronous machines, excitation system, turbines, governors, loads. Modelling of single machine-infinite bus system. Mathematical modelling of multi-machine system. Dynamic and transient stability analysis of single machine and multi-machine systems. Power system stabilizer design for multi-machine systems. Dynamic equi-valencing.

Voltage stability Techniques for the improvement of stability. Direct method of transient stability analysis: Transient energy function approach.

Text/ References

1. Power System Stability and Control, P. Kundur Mc-Graw Hills
2. Computer Techniques In Power System Analysis, M A Pai, Mc-Graw Hill
3. Advanced Power System Analysis And Dynamics, L.P. Singh, Mc-Graw Hill

EET-408 Energy Conservation and Management Credits: 4 (3-1-0)

Energy Conservation: Introduction, Motivation for Energy Conservation, Principles of Energy Conservation, Energy Conservation Planning, Energy Conservation in Industries, Electrical Energy Conservation in Small Scale Industries, Energy Conservation in Electrical Generation, Transmission and Distribution, Energy Conservation in Household and Commercial Sectors, Energy Conservation in Transport, Energy Conservation in Agriculture, Energy Conservation Legislation.

Cogeneration: Definition and Scope, Topping and Bottoming Cycles, Benefits, Industries Suitable for Cogeneration, Industrial Suitable for Cogeneration, Agricultural Uses of Waste Heat, Aquacultural Uses of Waste Heat, Use of Power Plant Reject Heat for Waste Water Treatment, Integrated Energy System, Potential of Cogeneration in India.

Energy Audit: Aim of Energy Audit, Energy Flow Diagram, Strategy of Energy Audit, Comparison with Standards, Energy Management Team, Considerations in Implementing Energy with Conservation Programmes, Periodic Progress Review, Instruments for Energy Audit, Energy Audit of Illumination System, Energy Audit of Electrical System, Energy Audit of Buildings.

Demand Side Management: Introduction, Scope of Demand Side Management, Evolution of DSM Concept, DSM Planning and Implementation, Load Management as a DSM Strategy, Applications of Load Control, End use Energy Conservation, Tariff Options for DSM, Customer Acceptance, Implementation Issues, Implementation Strategies, DSM and Environment, International Experience with DSM.

Energy and Sustainable Development: Introduction, Energy Problems, Energy use Trends in Developing Countries, Prospects of Changes in Energy Supply, Agenda for Sustainable Development.

Captive Power Generation: Introduction, Advantages, Constraints, Captive Generation Options, Government Polices, Types of Captive Power Plants, Future Prospects of Captive Power Generation in India, Captive Power Plants in India – Some Statistics, Energy Banking, Promotion of Captive Power Generation.

Environmental Aspects of Electric Energy Generation: Environment and its Quality, Man's Right to Modify Environment, Energy and Environment, Air Pollution, Stack Emissions, Cooling Tower Impacts, Aquatic Impacts, Nuclear Plant Impacts, Hydro-Plant Impacts, Social and Economic Impacts.

Texts/References

1. Gupta B. R.: Generation of Electrical Energy, Eurasia Publishing House Pvt. Ltd., New Delhi, 2001 IV Edition.
2. Durgesh Chandra &: Energy Scope, South Asian Publishers Pvt. Ltd, New Delhi.
3. M.V. Deshpande: Electrical Power System, Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. J. Nanda and D.P. Kothari: Recent Trends in Electric Energy Systems, Prentice Hall of India Pvt. Ltd, New Delhi.

EET-410 Advanced Control Systems Credit: 4 (3-1-0)

Control System Performance Objectives: Design of cascade compensators for continuous time and discrete time control systems, Feedback compensation, Design using Nichols chart

Industrial PID Controllers: state space systems and PID control, Automatic PID controller tuning, pole placement techniques for design of controllers and observers, design of integral controllers

Robust Control: H techniques, Non-linear control system design, Linearization, Describing function, use of describing function to predict oscillations, compensation and design of non-linear systems, Phase plane analysis

Introduction to Optimal Control Theory and Applications: Characteristics of optimal control problem, Calculus of variation, Dynamic programming, Pontryagin's maximum principle, application Control system design examples, Control system design using Toolboxes.

Text / References

1. S.M. Shinners, Advanced modern control system theory and design, John Wiley & Sons, 1998.
2. M.A. Johnson, Mohammad M. Moradi, PID Control: New Identification and Design Methods, Springer 2005.
3. N.S. Nise, Control Systems Engineering, John Wiley & Sons, Inc, 2000.

EET-412 Advances in Power Transmission & Distribution Credit: 4 (3-1-0)

Basic theory of line compensation. FACTS devices, The FACTS optimisation problem. Transient and dynamic stability enhancement using FACTS components. Concepts of modern grid.

Introduction to distribution automation, Layout of substations and feeders, Optimum siting and sizing of substations Distribution system load flow, configuration of distribution system, optimum capacitor placement. Optimum feeder switching for loss minimization and load control. Distribution system restoration. Distribution system monitoring and control: SCADA, Concept of modern distribution systems.

Text / References

1. Flexible Ac Transmission Systems, Yong-Hua Song, Allan T. Johns, IEE publication
2. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Narain G. Hingorani, Laszlo Gyugyi

EET-414 Power System Stability Credit: 4 (3-1-0)

Basic concepts and classification of different types of stability, static and dynamic modelling, different types of electrical loads and their modelling, state matrix, eigenvalues, eigenvectors, modal matrices, simulation of power system dynamic response, transient stability and small signal stability for large system, voltage stability: P-V curves, Q-V curves, sensitivity and continuation method; Voltage stability indices, Static and Dynamic analysis, local and global bifurcations, Margin prediction sub synchronous resonance.

Text / References

1. Power system voltage stability, C W Taylor, McGraw-Hill
2. Power System Stability and Control, P Kundur, McGraw-Hill
3. Voltage Stability of Electric Power Systems, T V Cutsem, Springer

EET-416 Applications of Power Electronics in Power Systems Credit: 4 (3-1-0)

Steady State and Dynamic Problems in AC Systems: Flexible AC transmission systems (FACTS), Principles of series and shunt compensation, Description of static VAR compensators

(SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC),

Modelling and Analysis of FACTS Controllers: Control strategies to improve system stability, Power Quality problems in distribution systems

Harmonics: harmonics creating loads, modelling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker, Mitigation of power quality problems using power electronic conditioners, IEEE standards, Need for HVDC, AC vs DC, Comparative advantages, Converters and their characteristics, Control of the converters (CC and CEA), Parallel and series operation of converters.

Text / References

1. N.G. Hingorani & Laszlo Gyugyi , Understanding FACTS , IEEE Press, 2000.
2. E. F. Fuchs & Mohammad A.S. Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press 2008.
3. K.R. Padiyar, FACTS controllers in power transmission and distribution, New Age International publishers, New Delhi, 2007.
4. K.R. Padiyar, HVDC Power Transmission Systems, New Age International publishers, New Delhi, 1999.

EET-418 Modelling & Simulation of Power Electronic Systems Credit: 4 (3-1-0)

Modelling of Power Electronic Converters: Modelling of semiconductor devices, Switch realization– single quadrant and two quadrant switches, switching losses,

Review of DC-DC converters: Steady-state analysis of converter in continuous and discontinuous modes (CCM & DCM), and estimation of converter efficiency, Development of circuit model for simulating dynamic operating conditions in CCM & DCM, Feedback control for converters,

Controller Design Dynamic Modelling of Electrical Machines: Modelling of DC machines, Modelling of three phase Induction machine, Reference frame theory – ARF, RRF, SYRF, SRF, equations of transformation, voltage equations, torque equations, analysis of steady-state operation, acceleration characteristics, effect of loading and operation with non-sinusoidal voltages,

Choice of Simulators: Power Electronic Circuit simulation using PSPICE, Analysis of Dynamic behaviour of Electrical Machines using MATLAB/SIMULINK.

Text / Reference

1. R.W. Erickson, Dragan Maksimovic, Fundamentals of Power Electronics (2 e), Springer, 2005.
2. P.C. Krause, O. Wasynczuk, S.D. Sudhoff, Analysis of Electrical Machinery & Derive Systems (2e), Wiley Student Edition, 2002.

EET-420 Modelling and Analysis of Electrical Machines Credit: 4 (3-1-0)

Generalised theory of machines. Transient analysis of AC machines. Space vectors and its application to the analysis of electric machines, specially of induction motors. Principle of vector decoupled control. Motor behaviour under asymmetrical supply voltages. Analysis of 3-phase induction motor with AC phase controlled supply. Harmonic effects on induction motor, harmonic equivalent circuit and harmonic torques. Theory of synchronous machines: Voltage and Torque equations in machine variables - equations in arbitrary reference frame - park's transformation. Application of simulation tools for machine modelling, analysis and design.

Text /Reference

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: "Analysis of Electric Machinery & Drive Systems" - IEEE Press, 2002
2. J.M.D. Murphy & F.G. Turnbull, "Power Electronic Control of AC Motors", Pergamon Press.
3. W. Shephard, L.N. Hulley & D.T.W. Liang,"Power Electronics and Motor Control", Cambridge University Press.
4. Rama Krishnan: Electric Motor Drives: Modelling, Analysis, and Control, Prentice Hall, 2001.
5. P.S. Bimbhra,"Generalised Theory of Electrical Machines", Khanna Publishers
6. C V Jones, The Unified Theory of Electrical Machines, Butterworth, London, 1967