Basics of Engineering

Field Theory and Circuits *Field Theory:*
Module 1: Review of Vector Analysis- Coordinate Systems, Vectors, gradient, divergence, curl, Laplacian, divergence theorem, Stoke"s theorem.
Module 2: Electric and Magnetic fields- Electric fields due to distributed charges configurations line(s) of charges, uniform plane surface and spherical volume charge distributions; behavior of conductors and dielectrics in electrostatic fields, boundary conditions, applications of ampere"s law and Biot- Savart"s law; capacitance and inductance calculations for simple configurations; time varying fields – displacement current, Maxwell"s equations; Laplace"s and Poisson"s equations. *Circuit Theory: Module 3:* Classification of circuits, sources and signals, standard signals, source transformations. Network topology, graph matrices, formulation and solution of circuit equations based on graph theory using different analysis techniques- circuit, cut set and mixed. Concept of duality. *Module 4:* Network theorems and their applications-Superposition, reciprocity, Thevenin, Norton, Maximum power transfer, Millman, Substitution, Compensation and Tellegan"s theorem. Analysis of circuits subject to periodic and non-periodic excitations using Fourier series and Laplace transforms.
Module 5: Concept of free and forced response of circuits. Time constants and Transient response under d. c. and a. c. excitation. Analysis of magnetically coupled circuits. Analysis of circuits with dependent sources.

Electronic Devices and Systems *Analog:*
Module 1: Transistor biasing circuits: CE, CC & CB amplifiers, Darlington amplifier. Hparameters and their application in analysis. Class A, B, C, D and S power amplifiers. Pushpull operation. JFET: Biasing and CS, CD and CG amplifier. MOSFET: Depletion type, Enhancement type MOSFET and their biasing.
Module 2: OP-AMP, Differential amplifier and its DC, AC analysis, OP-AMP characteristics, Non-Inverting/Inverting Voltage and Current feedback. Regulated power supplies; Oscillators and Timer (555) *Digital:*
Module 3: Logic gates and Logic Families: Logic gates, Universal gates, transistor as a switching element, Combinational Logic gates Introduction to combinational circuits, arithmetic and logical operation, design of Half adder & full adder, subtractor circuits, parity generator & and checker, code converter, decoders, multiplexers, demultiplexers, comparators.
Module 4: Sequential Circuits- Flip-flops, bistable circuits: RS, JK, D, T, Master/Slave Flipflop, race around condition, latches, synchronous and asynchronous counters up & down counters, shift registers, state transition diagram
Module 5: A/D & D/A Converters- D/A converter, accuracy, resolution and precision, variable resistor network, binary ladder, A/D converter, accuracy and resolution, simultaneous conversion, counter method, continuous A/D converter, dual slope, successive approximation method.

Electrical Machines
Module 1: Electromechanical Energy Conversion- Basic principle Energy, Force and Torque in singly and multiply excited systems.

Module 2: Transformers- (a) Principle, construction and operation of single phase transformers, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency.(b) Testing- Open & short circuit tests, Polarity test, Sumpner"s test, Separation of hysteresis and eddy current losses. (c) Three phase Transformer: Construction, various types of connection

and their comparative features. (d) Parallel operation of single phase and three phase transformers. (e) Autotransformers- Construction, Principle, Applications and Comparison with two winding transformer. (f) Excitation phenomenon in transformers, Harmonics in single phase and three phase transformers, Suppression of harmonics. (g) Phase conversion- Scott connections, Three phase to six phase conversion. (h) Tap changing Transformers- No load and on load tap changing of transformers. (i) Three winding Transformers. (j) Cooling methods of transformers.
Module 3: D.C. Machines- (a) Working principle, construction and methods of excitation.(b) Armature Winding- Detailed study of simple lap and wave windings.(c) D.C. Generatorsemf equation. Circuit models, Armature reaction, Effect of brush shift. Compensating winding, Characteristics of various types of generators, applications.(d) D.C. Motors- Torque equation, Circuit models Characteristics of d.c. shunt, series and compound motors, applications.(e) Starting & Speed Control- Starting methods and speed control of d.c. shunt and series motors. (f)Commutation- Causes of bad commutation, Methods of improvement. (g) Testing- Direct and regenerative methods to test d.c. machines

Measurements and Instruments
Module 1: Philosophy Of Measurement- Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement & its analysis, Standards.
Module 2: Analog Measurement of Electrical Quantities - Electrodynamic , Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters , Electrodynamic Wattmeter, Three Phase Wattmeter, Power in three phase system , errors & remedies in wattmeter and energy meter. Instrument Transformer and their applications in the extension of instrument range, Introduction to measurement of speed , frequency and power factor.
Module 3: Measurement of Parameters- Different methods of measuring low, medium and high resistances, measurement of inductance & capacitance with the help of AC Bridges, Q Meter.
Module 4: AC Potentiometer- Polar type & Co-ordinate type AC potentiometers , application of AC Potentiometers in electrical measurement
Module 5: Magnetic Measurement- Ballistic Galvanometer, flux meter , determination of hysteresis loop, measurement of iron losses

Module 6: Digital Measurement of Electrical Quantities-Concept of digital measurement, block diagram Study of digital voltmeter, frequency meter Power Analyzer and Harmonics Analyzer; Electronic Multimeter.
Module 7: Cathode Ray Oscilloscope - Basic CRO circuit (Block Diagram),Cathode ray tube (CRT) & its components , application of CRO in measurement ,Lissajous Pattern.; Dual Trace & Dua Beam Oscilloscopes

1. Calibration of ac voltmeter and ac ammeter;
2. Measurement of form factor of a rectified sine wave & determine source of error if r. m. s. value is measured by a multi-meter;
3. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.;
4. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor;
5. Measurement of low resistance by Kelvin"s double bridge;
6. Measurement of voltage, current and resistance using dc potentiometer;
7. Measurement of inductance by Maxwell"s bridge, Hay"s bridge, Anderson"s bridge;
8. Measurement of capacitance by Owen"s bridge, De Sauty bridge, Schering bridge;
9. Measurement of temperature by RTD, thermocouple and thermistor;
10.Study of Frequency and differential time counter;
11. Measurement of displacement using LVDT, strain gauge based displacement transducer and strain gauge based load cell;
12. Measurement of flow rate by anemometer;
13. Study of storage oscilloscope and determination of transient response of RLC circuit.

14.Study the diode clipping circuits.
15. Study the diode clamping circuits.
16. Study Zener diode as voltage regulator.
17. Study the common emitter configuration of a transistor.
18. Study the common base configuration of a transistor.
19. Study the common collector configuration of a transistor

Network Analysis and Synthesis

Module 1: Concept of generalized frequency, circuit representation and their response in terms of generalized frequency.

Module 2: Fourier transforms and series, Laplace transform, its properties, and Ztransforms, its properties and applications, Concept of one port, two-port networks, characteristics and parameters.

Module 3: Generalized network functions (Driving point and Transfer), concepts of poles and zeros, determination of free and forced response from poles and zeros, concept of minimum phase networks, analysis of ladder, lattice, T and bridged-T networks.

Module 4: Introduction to state-space representation of networks and their analysis. Concept of filtering, filter types and characteristics, classical design of T and PI passive filters, frequency transformations. Introduction to active filters, active filter specifications, design of first and second order RC –active filters, maximally flat and equi-ripple filter characteristics, implementation using passive elements and op-amps.

Module 5: Network synthesis- Synthesis problem formulation, properties of positive real functions, Hurwitz polynomials, properties of RC, LC and RL driving point functions, Foster and Cauer synthesis of LC and RC circuits.

Power Electronics

Module 1: Characteristics and switching behavior of different solid-state devices namely Power Diode, SCR, UJT, TRIAC, DIAC, GTO, MOSFET, IGBT, MCT and power transistor. Two-transistor analogy of SCR, Firing circuits of SCR and TRIAC, SCR gate characteristics,

Module 2: SCR ratings. Protection of SCR against over current, over voltage, high dV/dt, high dI/dt. Thermal protection Methods of commutation. Series and Parallel operation of SCR.

Module 3: Classification of Rectifiers, Phase controlled rectifiers: Single phase half wave controlled. Fully controlled and half controlled rectifiers and their performance parameters.

Module 4: Three phase half wave, full wave and half controlled rectifiers and their performance parameters. Effect of source impedance on the performance of single phase and three phase controlled rectifiers. Single-phase and three phase Dual Converter

Electrical Machines

Module 1: Basic concepts of Electrical Machines-Winding factors, generated e. m. f., m. m. f. of distributed a.c. winding, rotating magnetic field.

Module 2: Induction Machines (a) Constructional features, production of torque, phasor diagram, equivalent circuit, performance analysis, torque-slip characteristics. (b) Testing-Running light and blocked rotor test, load test. (c) Effect of rotor resistance, deep bar and double cage induction motor. (d) Generator Operation (e) Starting- Starting methods of squirrel cage and wound rotor induction motor. (f) Speed Control- Various methods of speed control of squirrel cage and wound rotor induction motor. (g) Effects of space harmonics.

Module 3: Single phase induction motors- Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split phase starting methods & applications.

Module 4: Synchronous Machines (a) Constructional features. (b) Cylindrical rotor machine-I) Synchronous Generator- Generated e.m.f., circuit model and phasor diagram, armature reaction, synchronous impedance, voltage regulation and different methods for its estimation. II) Synchronous Motor- Operating principle, circuit model, phasor diagram, effect of load.III) Operating characteristics of synchronous machines, V-curves, starting methods of synchronous motors. (c) Salient pole Machine- Two reaction theory, analysis of phasor

diagram, power angle characteristics, determination of x_d and x_q. (d) Parallel operation of Alternators-Synchronization and load division.

Power Systems

Module 1: Generation of Electric Power- Brief description of Thermal, hydro nuclear and gas power plants & other non-conventional power plants.

Module 2: Transmission and Distribution Systems- DC 2 –wire and 3 – wire systems, AC single phase, three phase and 4-wire systems, comparison of copper efficiency. Distribution Systems: primary and secondary distribution systems, concentrated & uniformly distributed loads on distributors fed at one and both ends, ring distribution, submains and tapered mains, voltage drop and power loss calculations, voltage regulators.

Module 3: Overhead Transmission Lines- Types of Conductors, Line parameters; calculation of inductance and capacitance of single and double circuit transmission lines, three phase lines with stranded and bundle conductors, Generalized ABCD constants and equivalent circuits of short, medium & long lines. Line Performance: regulation and efficiency of short, medium and long lines, Series and shunt compensation, Introduction to FACTS.

Module 4: Overhead Line Insulators- Type, string efficiency, voltage distribution in string of suspended insulators, grading ring, preventive maintenance.

Module 5: Mechanical Design of Transmission Lines- Different types of tower, sag-tension calculations, sag-template, string charts, vibrations & damaging Corona-corona losses, radio & audio noise, transmission line – communication line interference.

Module 6: Tariffs & Load Curves- Definition & different tariffs for domestic, commercial, industrial application, Different Load and Load duration curves. Curves their significance.

Module 7: Introduction to EHV/HVDC transmission- Brief description of both the systems with working & constructional details.

Control Systems

Module 1: Introduction to Control Systems- Concept of control, control system terminology, classification of Control Systems.

Module 2: Mathematical Models of Systems- Differential equations of physical systems, transfer function of linear systems, block diagram models, signal flow graph. D.C. & A.C. Servomotors, Synchros.

Module 3: State Variable Models- State variables of a dynamic system, state equation, transfer function from the state equation and vice-versa.

Module 4: Feedback Control System Characteristics- Time domain and frequency domain responses and characteristics, steady state error, performance indices, concept of stability.

Module 5: Analysis of Linear Feedback Systems- R-H stability criterion, Nyquist criterion, Bode plot, Root locus and Lyapunov"s criterion.

Module 6: Design of Feedback Control System-Approaches to system design, phase lead, phase lag design using Bode-diagram and root locus techniques

Module 7: Design using State variable Feedback- Controllability, observability, pole placement using state feedback, Ackerman"s formula, limitations of state variable feedback. Introduction to P/I/D and ON-OFF control actions.

Module 1: Representation of Power System Components- Synchronous machines, Transformers, Transmission lines, one line diagram, Impedance and reactance diagram, per unit System

Module 2: Symmetrical components- Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks.

Module 3: Symmetrical fault analysis- Transient in R-L series circuit, calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions

Module 4: Unsymmetrical faults-Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Z_{bus} using singular transformation and algorithm, computer method for short circuit calculations

Module 5: Load Flow- Introduction, bus classifications, nodal admittance matrix (Y_{BUS}), development of load flow equations, load flow solution using Gauss Siedel and Newton Raphson method, approximation to N-R method, line flow equations and fast decoupled method
Module 6: Power System Stability- Stability and Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step-bystep method. Factors affecting steady state and transient stability and methods of improvement
Module 7: Power Control- Concept of Load frequency control, Concept of voltage and reactive power control

Microprocessors and Microcontrollers
Module 1: Microprocessor Architecture-8085 microprocessor architecture, timing and control unit, machine cycles, interrupt diagram. Architecture of 8086 microprocessor
Module 2: Programming- Addressing modes, instruction set, assembly language programming, program for multi byte addition/subtraction, multiplication, division, block transfer.
Module 3: Interfacing- Basic principles of interfacing memory and I /O devices. Data transfer techniques – programmed interrupt and DMA. Details of interfacing devices 8255 and 8253. Interfacing of D/A and A/D converter.
Module 4: Semi Conductor Memory- Read only memories, random access memories. Interfacing of memories with 8085/86.
Module 5: Microcontroller- Architecture of 8051 microcontroller. Interrupt, serial and timer control. Instruction set and programming. Interfacing with D/A and A/D converter. Applications of microprocessors and microcontrollers

Electric Drives
Module 1: Introduction- Classifications of Electric Drives, components of electric drives, advantages of electric drives, Review of characteristics and speed control of d.c. and a.c. motors.
Module 2: Dynamics of Electric Drives:- Fundamental torque equation, speed-torque conventions and multiquadrant operation, equivalent values of drive parameters, components of load torques, nature and classification of load torques, calculation of time and energy-loss in transient operations, criteria for steady state stability, load equalization.
Module 3: Rating and Heating of Motors- Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating, frequency of operation of motors subjected to intermittent loads.
Module 4: Rectifier Control of D.C. Drives- Controlled rectifier circuits, 1-phase fully controlled rectifier-fed separately excited d.c. motor, 1-phase half-controlled rectifier-fed separately excited d.c. motor, 3-phase fully controlled rectifier-fed separately excited d.c. motor, multi quadrant operation of fully-controlled rectifier-fed d.c. motor.
Module 5: Chopper Control of D.C. Drives- Principle of operation and control techniques, motoring operation of separately excited and series excited motors, multi quadrant control of chopper-fed motors.
Module 6: Induction Motor (IM) Drives:- 3-phase a.c. voltage controller-fed IM drive, voltage source inverter (VSI) and current source inverter (CSI) variable frequency drives, comparison of VSI and CSI drives, cyclo-converter-fed IM drive, static rotor resistance control of 3-phase slipring IM.
Module 7: Synchronous Motor Drives- VSI drive, CSI drive, CSI drive with load commutation, cyclo-converter drive,
Module 8: Braking methods- Various methods of braking d.c. and a.c. motors, regenerative braking of d.c. motors during chopper control, static scherbius drive, commutatorless Kramer drive. Introduction to Microprocessor Control of Electric Drives

Computer Aided Analysis and Design

Module 1: Introduction to computer aided tools for analysis and design- software and hardware PSPICE /PSIM / MATLAB-SIMULINK/ MATHEMATICA/ 20SIM / LABVIEW / DSPACE (description as per choice/ availability)

Module 2: Modelling of Electrical/Electronic components and systems, Time and Frequency domain analysis, parameter variations, response representation storage/import/export.

Module 3: Optimization methods: parametric optimization and functional optimization. Design issues of Electrical/Electronic components and systems.

Module 4: Applications for control systems, power systems and electrical machines

Computer Organization and Architecture

Module 1: Introduction to basic computer architecture, register transfer, bus and memory transfers, arithmetic, logic and shift micro operations.

Module 2: Instruction codes, computer registers, computer instructions, timing and control, instruction cycle, memory reference instructions, I/O interrupt, complete computer description, design of basic computer, design of accumulator logic.

Module 3: Micro programmed control, control memory, address sequencing, micro program example, design of control unit.

Module 4: Central Processing Unit: Introduction, general register organization, stack organization, instruction formats, addressing modes, data transfer and manipulation, program control, RISC.

Module 5: Pipeline and Vector Processing: Parallel processing, pipelining, arithmetic pipeline, instruction pipeline, RISC pipeline, vector processing, array processors.

Module 6: Input-output Organisation: Peripheral devices, input-output interface, asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP serial communication.

Module 7: Memory Organisation: Memory hierarchy, main memory, auxillary memory, associative memory, cache memory, virtual memory, memory management, hardware multiprocessor architectures and their characteristics, interconnection structures, inter processor arbitration, inter-processor communication and synchronization, cache coherence

Communication Systems

Module1: Introduction to Communication Systems: Block diagram, modulation and demodulation, need for modulation, transmission considerations and decibel ratios.

Module2: Amplitude modulation, generation of AM waves, concept of SSB and DSB modulation, vestigial sideband transmission, power-relationships, AM receivers, S/N ratio.

Module3: Phase and frequency modulation, pre-and de-emphasis, generation of FM waves, CW modulation systems, narrowband FM, FM detectors and superheterodyne receivers, S/N ratio.

Module4: Concepts of information, Shannon-Hartley theorem, bandwidth-S/N ratio tradeoff, coding, codes for error detection and correction, convolution codes, block and trellis codes.

Module5: Pulse modulation, PAM, PPM, PWM systems. Concept of PCM, basic coding and quantization, sample and hold, quantization noise, signal to noise ratio, companding, TDM, Delta modulation, adaptive delta modulation, S/N ratio, comparison of PCM, delta and adaptive delta modulation

Module6: ASK, PSK, FSK, differential PSK and quadriphase shift keying, synchronization concepts and phase locked loops.

Module7: Block diagram of Fibre optic communication systems, light propogation in optical fibres, numerical aperature and acceptance cones of OFs, losses in optical fibres. Multiplexing in optic Fibre links.

Module8: An introduction to telephone exchange systems. Telecommunication traffic, circuit switching, message switching and packet switching. Resource sharing and multiple access techniques.

Module9: An introduction to microwave, radar and satellite communication.

Information Technology

Module 1: An overview of the revolution in computers and communications.
Module 2: Applications software, common features of software speciality software, Ethics & Intellectual Property Rights.
Module 3: Systems software, common operating systems, software for online computing.
Module 4: System Unit: System board, microprocessor.
Module 5: Input and output: Keyboard, pointing, scanning, voice input devices, voice recognition system, monitors, printers, plotters, voice output devices.
Module 6: Secondary storage: Floppy, hard, optical disks, CD-R Drives.
Module7: Communication and Connectivity: E-mail, fax, voice messaging system, user connection, communication channels, data transmission, network types.
Module8: Internet and Web: Applications, Access, E-mail, discussion groups, E-commerce, services, browsers, web pages, multimedia, graphics program, virtual reality privacy, security and other such issues.

Information Security

Module1: Information Security and privacy, introduction, Security levels, Security aims.
Module2: System Security – Security models, Security functions and Security Mechanisms, Privacy enhancing Mechanisms, Access control: role based attribute based, Data base Security, Secure programming, Security evaluation criteria.
Module3: Network Security – Security Threats and vulnerabilities, Firewalls, IDS, VPNS, Router Security, Viruses, Worms, DoS, DDos attacks, OS Security, Security protocols, Security management,
Module 4: Audit and Assurance, Standards, Availability, Survivability, Introduction to disaster recovery and Forensics.
Module5: Introduction to Cryptography.

Digital Signal Processing

Module1: The Z-Transform analysis of LTI Systems: Analysis of LTI systems in z-domain, transient and steady -state response, causality and stability, Shur-Cohn stability test, Jury test, Shur-Cohn-Fuzzivera stability criterion.
Module2: DFT and FFT: DFT and its properties, linear filtering using DFT, Direct computation of DFT, circular convolution, FFT algorithms; Geortzel algorithm, Radix-2 and Radix-4 algorithms, Chirp-Z algorithm. Circular convolution and fast linear convolution.
Module3: Implementation of Discrete time Systems: Direct form, cascade form, frequency selective and lattice structure for FIR filters, direct form, signal flow graph and transposed structure for IIR filters, cascade, parallel and lattice structure for IIR filters, state space structure.
Module4: Design of Digital Filters: Design of FIR filters, window method, frequency sampling method, design of IIR filters by approximation of derivatives, quantization effects in digital filters. Bilinear transformation, characteristics of some commonly used analog filters for design of IIR filters, least square methods.
Module5: Time-Frequency Analysis: Introduction to wavelets and wavelet transforms.
Module6: Brief introduction to DSP architecture: Pipeline, lattice and systolic architecture

Database Systems

Module1: Identification of need for computerization; Pole, Tasks, Attributes and Tools of System Analyst;
Module2: Information Collection: Sources, searching Methods, Interviewing Techniques; Feasibility, Economic and Technical Analysis, Allocation and Trade –off. Requirements and Specifications.
Module3: Need for a DBMS, Uses of a DBMS, Advantages. Introduction to Data models, Schemes, Architecture, Languages and Environment. Entity-Relationship concepts, Attributes, Domains, keys, Foreign Keys, ER Diagram, Naming

High Voltage Engineering

Module1: Conduction & Breakdown in Gases, Liquid & Solid Dielectrics: Gases -Ionization process, town send"s current growth equation. Ist & 2nd ionisation coefficients. Townsend criterion for breakdown. Streamer theory of breakdown. Paschen"s law of gases. Gases used in practice.

Module2: Liquid Dielectrics-Conduction & breakdown in pure & commercial liquids, suspended particle theory, stressed oil volume theory, liquid dielectrics used in practice; Solid Dielectrics-Intrinsic, electromechanical, & thermal breakdown, composite dielectric, solid dielectrics used in practice; Applications of Insulating Materials: Application of insulating materials in power transformers, rotating machines, circuit breakers, cables & power capacitors.

Module3: Generation of High Voltages & Currents: Generation of high D.C., A.C., impulse voltage & impulse currents. Tripping & control of impulse generators; Measurement of High Voltages & Currents: Measurement of high D.C., A.C. (Power frequency & high frequency) voltages, various types of potential dividers, generating voltmeter, peak reading A.C. voltmeter, Digital peak voltmeter, electrostatic voltmeter. Sphere gap method, factors influencing the spark voltage of sphere gaps.

Module4: High Voltage Testing of Electrical Apparatus: Testing of insulators, bushings, circuit breakers power capaitors & power transformers.

Module 5: Over voltage Phenomenon & Insulation Co-ordination: Theory of physics of lightning flashes & strokes. Insulation co-ordination, volt-time and circuit time characteristics. Boys camera, standard voltage & current shapes produced in Lab., Horn gap, single diverters, ground wires, surge absorbers.

Module 6: E.H.V. Transmission & Corona Labs: Need for E.H.V. transmission, use of bundled conductors, corona characteristics of smooth bundled conductors with different configurations, corona loss, factors affecting the corona. Shunt & series compensation of E.H.V. lines. Tuned power lines.

Module 7: H.V.D.C. Transmission: Advantages, disadvantages & economics of HVDC transmission system. Types of d.c. links, converter station equipment, their characteristics

Mechatronics

Module1: Introduction to Mechatronics and its Systems; Evolution, Scope, Measurement Systems, Control Systems, open and close loop systems, sequential controllers, microprocessor based controllers, mechatronics approach.

Module2: Basics of Digital Technology Number System, Boolean algebra, Logic Functions, Karnaugh Maps, Timing Diagrams, Flip-Flops, Applications.

Module3: Sensors and transducers -Introduction, performance terminology-Displacement, Position and Proximity, Velocity and motion, force, Fluid Pressure-Temperature Sensors-Light Sensors-Selection of Sensors-Signal Processing.

Module4: Pneumatic and Hydraulic actuation systems: actuation systems, Pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, process control valves, rotary actuators.

Module5: Mechanical actuation systems -Mechanical systems, types of motion, kinematics chains, cams, gear trains, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection.

Module6: Microprocessors-Introduction, Architecture, Pin Configuration, Instruction set, Programming of Microprocessors using 8085 instructions-Interfacing input and output devices-Interfacing D/A converters and A/D converters, Applications, Temperature control, Stepper motor control, Traffic light controller.

Design of Electrical Machines

Module1: Review of Magnetic and insulating materials.

Module2: Principles of design of Machines: Factors and limitations in design, specific magnetic and electric loadings, output, real and apparent flux densities, separation of main

dimensions for D.C., induction and synchronous machines.
Module3: Heating, Cooling and Ventilation: Temperature rise calculation, continuous, shorttime and intermittent ratings, types of ventilation, hydrogen cooling and its advantages.
Module4: Design of Transformers: General considerations, output equation, main dimensions, leakage reactance, winding design, tank and cooling tubes, calculation of magnetizing current, losses, efficiency and regulation.
Module5: Design Three-phase induction motors: General considerations, output equation, choice of specific electric and magnetic loadings, No. of slots in stator and rotor, elimination of harmonic torques, design of stator and rotor windings, leakage reactance, equivalent resistance of squirrel cage rotor, magnetizing current, temperature rise and efficiency.
Module6: Design of Alternators: Classification and their comparison, specific loadings, output coefficient, main dimensions, short circuit ratio, elimination of harmonics in generated EMF, stator winding design.
Module7: Introduction to computer aided electrical machine design.

Computational Intelligence
Module1: Introduction to the concept of A.I.
Module2: Problem Solving: General problem solver, Contributions of GPS to recursive programming, problem representation and extrapolation, Cybernetics and adaptive control. Accomplishments and limitations of GPS.
Module3: Production systems: design, implementation and limitations.; Game Playing: History of A.I. in game playing, game trees and graph theory. Mini-max procedure, pruning the game tree.
Module4: Knowledge representation: Features of knowledge representation schemes, design considerations for a knowledge representation system. Semantic networks, Minsky theory of frames, Script theory of Schank and Abelson.
Module5: Searching techniques: Basic search techniques, Airline booking problem, Tower of Hanoi problem, Traveling salesman problem, graphs and goal trees. Depth-first search, breadth-first search, hill climbing, heuristics, best-first heuristics.
Module6: LISP/Prolog programming language.
Module7: Expert Systems: Structure of an expert system. Organisation and representation of knowledge in an expert system. Basic activities of an expert system. Expert system shells. Few examples of expert systems.
Module 8: Introduction to fuzzy sets, fuzzy mathematics, membership functions, design of a fuzzy model & its working, steps of working – fuzzification, composition, implication, aggregation, defuzzification.
Module 9: Introduction to ANN, feedforward and feed back network, neural network learning rules, perceptron classifier, LMS algorithm, multilayer feedforward neural network, back propagation learning algorithm, Hopfield neural network, associative memories. Selforganizing feature map; Application of ANN & Fuzzy Systems.

Non-Conventional Energy Sources and Applications
Module1: Introduction: Limitations of conventional energy sources, need and growth of alternate energy sources, basic schemes and applications of direct energy conversion.
Module2: MHD Generators: Basic principles and Hall Effect, generator and motor effect, different types of MHD generators, conversion effectiveness. Practical MHD generators, applications and economic aspects.
Module 3: Solar Energy: Photovoltaic effect, characteristics of photovoltaic cells, conversion efficiency, solar batteries and applications. Solar energy in India, solar collectors, solar furnaces & applications.
Module4: Wind Energy: History of wind power, wind generators, theory of wind power, characteristics of suitable wind power sites, scope in India, advantages and limitations.
Module5: Thermo-electric Generators: Seeback effect, peltier effect, Thomson effect, thermoelectric convertors, brief description of the construction of thermoelectric generators, applications and economic aspects.
Module6: Fuel Cells: Principle of action, gibbs free energy, general description of fuel cells,

types, construction, operational characteristics and applications.
Module7: Miscellaneous Sources: Geothermal system, characteristics of geothermal resources, choice of generators, electric equipment and precautions. Low head hydro plants, definition of lowhead hydro power, choice of site and turbines. Tidal energy, idea of tidal energy, tidal electric generator, limitations.

Computer Networks
Module1: Introduction- Goals and applications of Networks, Network structure and architecture, The OSI reference model, services, Network Topology Design-Delay Analysis, Back Bone Design, Local Access Network Design.
Module2: Physical Layer Transmission Media, Switching methods , ISDN, Terminal Handling. Medium Access Control sub layer: Medium Access sub layer-Channel Allocation, LAN protocols-ALOHA protocols-Overview of IEEE standards – FDDI, Data Link Layer – Elementary data Link Protocols, Sliding Window protocols, Error Handling.
Module3: Network Layer: Network Layer – Point – to Point Networks, routing, Congestion control, Internetworking – TCP /IP –IP packet, IP address, IP v6.
Module4: Transport Layer: Transport Layer – Design issues, connection management, session Layer – Design issues, remote procedure call, Presentation Layer – Design issues, data compression techniques, cryptography – TCP Window Management.
Module5: Application Layer: Application Layer-File Transfer, Access and Management, Electronic mail, Virtual Terminals, Other application, Example Networks – Internet and Public Networks.

Advanced Power Electronics
Module1: D.C. to D.C. Converter: Classification of choppers. Principle of operation, steady state analysis of class A chopper, step up chopper, switching mode regulators: Buck, Boost, Buck-Boost, Cuk regulators. Current commutated and voltage commutated chopper.
Module2: A.C. to A.C. Converter: Classification, principle of operation of step up and step down cycloconverter. Single phase to single phase cycloconverter with resistive and inductive load. Three phase to single phase cyclo converter: Half wave and full wave. Cosine
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wave crossing technique. Three phase to three phase cyclo converter. Output voltage equation of cyclo converter.
Module3: D.C. to A.C. Converter: Classification, basic series and improved series inverter, parallel inverter, single phase voltage source inverter, steady state analysis, Half bridge and full bridge inverter: Modified Mc Murray and Modified Mc Murray Bedford inverter, voltage control in single phase inverters, PWM inverter, reduction of harmonics, current source inverter, three phase bridge inverter.
Module4: Power Supplies: Switched mode D.C. and A.C. power supplies. Resonant D.C. and A.C. power supplies.
Module5: Applications: Dielectric and induction heating. Block diagram of D.C. and A.C. motor speed control.

Materials in Electrical Systems
Module1: Materials- Conductors-free electron theory and electron scattering Dielectrics-Polarization, solid, liquid and gas dielectrics Insulators-Classification, Application in electric devices. Magnetic materials-classification based on orientation of magnetic dipoles, Optoelectronic materials, Semiconductors-simple and compound, Refractory Materials. Solders and contacts, Superconductivity and super conducting materials.
Module2: Components- Resistors and Capacitors. Display units:-LED, LCD and Monitors. Effect of environment on components.
Module3: Processes- Basic processes used in the manufacture of integrated circuits such as Epitaxy, masking, photolithography, diffusion, oxidation, Etching, metallization, Scribing, wire bonding and Encapsulation. Induction and Dielectric heating. Electron beam welding and cutting.
Module4: Cables- Calculations of capacity of cables, charging current, stress, grading,

heating of cables, Construction and characteristics of HV & EHV cable

Switchgear and Relaying

Module1: Switchgear- Introduction, functions of a circuit breaker, contacts separation and arc phenomenon, theory of arc formation and its extinction, recovery voltage, restriking voltage, interruption of capacitive and inductive currents, resistance switching, double frequency transients, circuit breaker ratings, clearing time, reclosing time, classification of circuit breakers, oil, air-blast, vacuum and SF6 circuit breakers.
Module2: Protection Against Lightning- Lightning mechanism and its characteristics, overvoltages due to lightning, protection of lines and sub-stations against lightning using shield wires, tower footing resistance, counterpoises, ground wires, rod gaps, lightning arrestors, their construction, working and ratings, surge absorbers and surge divertors.
Module3: Insulation Co-ordination: Impulse volt-time characteristics of electrical apparatus, basic impulse insulation level, insulation levels of sub-station equipments.
Module4: Protective Relays: Introduction, basic requirements, operating principles and characteristics of electromagnetic type over-current, differential, impedance and admittance relays. Detail of protection against abnormal conditions for alternators, transformers, feeders transmission lines, and bus-bars. Carrier current protection for long lines.
Module5: Static Relays: Introduction, comparison with electromagnetic relays, working of instantaneous, definite time, inverse time and directional over current relays, introduction to digital relays.
Module6: Sub-Stations: Types of sub-stations, sub-station equipments and outdoor yard layout, types of bus-bars, key diagrams and bus-bar arrangements.

Utilization of Electrical Energy & Electric Traction

Module1: Illumination- Nature of light, important definitions, laws of illumination, principle of production of light- discharge through gases under pressure – incandescence/sources of light-filament lamp, halogen lamp-discharge lamp-sodium discharge lamp,high pressure mercury discharge lamp, dual lamps, fluorescent lamps, lamp efficiency,requirements of good lighting, illumination level, absence of contrasts, shadows, glare, colour rendering-lamp fittings. Lighting schemes,design of indoor & outdoor lighting system-street lighting,flood lighting, photometers.
Module2: Electric Heating- Advantages of electric heating, classification of heating methods, detailed study of resistance heating, arc heating, electron bombardment heating, induction heating & dielectric heating and their control.

Module3: Electrolytic Processes- Fundamentals of electro deposition-laws of electrolysis applications of electrolysis, electro deposition, manufacture of chemicals, anodizing, electropolishing,electro-cleaning, electro-parting, electrometallurgy, electric supply.
Module4: Train Mechanics- Types of services, characteristics of each type of service, speed time curve, simplified speed time curve, average speed, schedule speed, factors affecting schedule speed, tractive effort for propelling a train, power of the traction motor, specific energy output, specific energy consumption, factors affecting specific energy consumption, mechanics of train movement, coefficient of adhesion, factors affecting slip.
Module5: Electric Traction- D.C. & A.C. traction motors, their characteristics Traction Motor Control: Starting and speed control of D.C. series motors, shunt transition, bridge transition, drum controller employing shunt transition, energy saving with series parallel starting, metadyne control, multiple unit control, braking of traction motors.
Module6: Current Collection Systems- Conductor rail equipment, current collection gear for OHE: Cable collector, pole collector, bow collector, pantograph collector

Note: The above syllabus is indicative and not exhaustive

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