2. ELECTRICAL ENGINEERING

Paper-I

1.Electrical Circuits–Theory and Applications

Circuit components; network graphs; KCL, KVL; circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits and applications; coupled circuits and applications; balanced 3-phase circuits. Two-port networks, driving point and transfer functions; poles and zeros of network functions. Elements of networks synthesis. Filter-theory : design and applications. Active filters. Circuit simulation : Input formats; mathematical modelling; solution of equations; output formats; SPICE.

2.Signals & Systems

Representation of continuous–time and discrete-time signals; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

3. E.M. Theory

Maxwell's equations, wave propagation in bounded media. Boundary conditions, reflection and refraction of plane waves. Transmission line : Distributed parameter circuits, travelling and standing waves, impedance matching, Smith chart. Waveguides : parallel plane guide, TE, TM and TEM waves, rectangular and cylindrical wave guides, resonators. Planar transmission lines; stripline, microstripline.

4. Analog Electronics

Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET. Diode circuits : clipping, clamping, rectifier. Biasing and bias stability. FET amplifiers. Current mirror, Amplifiers : single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequencyresponse of amplifiers. OPAMP circuits. Filters; sinusoidal oscillators : criterion for oscillation; single-transistor and OPAMP configurations for oscillators. Function generators and wave-shaping circuits. Power supplies.

5. Digital Electronics

Boolean algebra; minimisation of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits : arithmetic circuits, code converters, multiplexers and

decoders. Sequential circuits : latches and flip-flops, counters and shift-registers. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Programmable logic controller.

6.Energy Conversion

Principles of electromechanical energy conversion : Torque and emf in rotating machines. DC machines : characteristics and performance analysis; starting and speed control of motors. Transformers : principles of operation and analysis; regulation, efficiency; 3-phase transformers, 3-phase induction machines : Characteristics, speed control. 3-phase synchronous machines : Characteristics, parallel operations. Reactive power control. Special machines : stepper motors, brushless dc motors, permanent magnet motors single-phase motors; Universal Motors.

7.Power Electronics and Electric Drives :

Semiconductor power devices: diode, transistor, thyristor, triac, GTO , MOSFET and IGBT; static characteristics and principles of operation; triggering circuits; bridge converters : fully-controlled and half-controlled; principles of choppers and inverters; basic concepts of speed control of dc and ac motor drives, applications of variable-speed drives.

Paper-II

1.Control Systems

Elements of control systems; block-diagram representation; open-loop & closedloop systems; principles and applications of feed-back. LTI systems : timedomain and frequency-domain analysis. Stability : Routh Hurwitz criterion, rootloci, Nyquist's criterion, Bode-plots, Design of lead-lag compensators. Proportional, PI, PID controllers. State-variable method and application. Principles of discrete-control systems.

2.Electrical Engineering Materials

Electrical/electronic behaviour of materials : conductivity; free-electrons and band-theory; intrinsic and extrinsic semiconductor, p-n junction; superconductivity. Dielectric behaviour of materials; polarization phenomena; piezoelectric phenomena. Magnetic materials : behaviour and application. Photonic materials : refractive index, absorption and emission of light, optical fibres, lasers and opto-electronic materials.

3.Microprocessors and microcomputers

8-bit microprocessor : architecture, CPU, module design, memory interfacing, I/O, Periphe controllers,Application. IBM PC architecture : overview, introduction to DOS, Advanced microprocessors.

4. Measurement and Instrumentation

Error analysis; measurement of current, voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency. Electronic measuring instruments : multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyser, distortion-meter. Transducers : thermocouple, thermistor, LVDT, strain-guage, piezo-electric crystal. Use of transducers in measurements of non-electrical quantities. Data-acquisition systems.

5.IC Technology

Overview of IC Technology. Unit-steps used in IC fabrication : wafer cleaning, photo-lithography, wet and dry etching, oxidation, diffusion, ion-implantation, CVD and LPCVD techniques for deposition of poly-silicon, silicon, siliconnitride and silicon di-oxide; metallisation and passivation.

6.Power Systems : Analysis and Control

Power Generation concepts, Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer, Distribution system; Per-unit quantities; Bus admittance and impedance matrices; load flow; economic operation; Symmetrical components, analysis of symmetrical and unsymmetrical faults. Concept of system stability : swing curves and equal area criterion. Flexible AC Transmission Systems (FACTS). Computer control and Automation : Introduction to energy control centres; various states of a power system; SCADA systems and RTUs.

7.Power system protection

Principles of over current, differential and distance protection. Concept of solid state relays. Circuit brakers. Load frequency control, Reactive power control. Line bus, generator, transformer protection; numeric relays and application of DSP to protection. Computer aided protection.

8.Non-conventional Energy Sources and Energy Management

Introduction to the energy problem; difficulties with conventional energy sources. Wind-Energy: Basics of Wind turbine aerodynamics; wind-energy conversion systems and their integration into electrical grid. Solar-Energy : Thermal conversion : photo-voltaic conversion. Wave-energy. Importance of Energy Management : Energy audit; energy economics : discount rate, payback period, internal rate of return, life cycle costing.