ELECTRICAL ENGINEERING

1. Circuit Theory

Circuit components, Network graphs, Kirchhoff's current law (KCL), Kirchhoff's voltage law (KVL), Circuit analysis methods: Nodal analysis, Mesh analysis, Basic network theorems; Transient analysis: RL, RC, and RLC circuits; Sinusoidal steady state analysis, Resonance, Quality factor, Balanced three-phase circuit analysis. Frequency domain analysis, Laplace's transform, Fourier series (Trigonometric and exponential). Two-port networks and their various parameters; Poles and zeros driving point and transfer function. Passive filter design.

2. Electro-magnetic Field Theory and Materials

Electrostatic and magneto static field, Laplace's and Poisson's equations, Boundary value problems and solutions; Maxwell's equation, Electromagnetic wave propagation: Reflection and refraction of plane waves. Poynting vector, Wave propagation through dielectrics and band-theory; Intrinsic and extrinsic semi-conductors, p-n junction; Solar cells, Superconductivity. Dielectric behavior of materials: Polarization phenomena; Piezo-electric phenomena. Magnetic material, Superconductivity.

3. Measurement and Instrumentation

Error analysis, Measurement of current, Voltage, Power, Energy, Power factor, Resistance, Inductance, Capacitance, and frequency analysis of bridges. Electronic measuring instruments: Multimeter, Cathode ray oscilloscope (CRO), Digital volt meter, Frequency counter, Q-meter transducers, Measurements of non-electrical quantities by electrical methods, Measurement of displacement, Temperature, Velocity, Pressure, Signal conditioning, Data acquisition system.

4. Analog and Digital Electronics

Characteristics andequivalent circuits (for small and large signals concept for diode, bipolar junction transistor (BJT), junction gate field-effect transistor (JFET), and Metal-oxide-semiconductor field-effect transistor(MOSFET) clipping, Clampingand rectifier circuits,Biasing and bias stability. Amplifiers: Single and multi-stage, Differential, Operational, Feedback, and Power. Analysis of amplifiers; Frequency-response of amplifiers.Operational amplifier (OPAMP) circuits. Filters; Sinusoidal oscillators: Criterion for oscillation; Single-transistor and OPAMP configurations. Function generators and wave-shaping circuits. Power supplies.

Boolean algebra, Boolean function minimization. Logic gates, Combinatorial circuits: Arithmetic circuits, Code converters, Multiplexers and decoders, Sequential circuit: Latches and flip flops, Counters, Shift registers, Comparators, Timers, Multivibrators, Sample and hold circuits, ADCs and DACs. Semiconductor memories, Logic implementation using programmable devices (ROM, PLA etc.)

5. Power Electronics

Semiconductor power devices: Diode, Transistor, Silicon controlled rectifier (SCR), Triac, Gate turn-off thyristor (GTO), MOSFET and Insulated-gate bipolar transistor (IGBT), Triggering circuits, Gate driver circuits. Phase control rectifiers, Inverters, and DC-DC converters, Bridge convertors: Fully controlled and half controlled, principles of choppers and inverters.

6. Signals and Systems

Representation and classification of signals and systems; Linear time Invariant (LTI) systems; Convolution, impulse response; time-domain analysis of LTI systems based on convolution and differential equations, Fourier transform, Laplace transform, Z transform, transferfunction, sampling of signals, discrete Fourier transform (DFT), fast Fourier transform (FFT), processing of analog signals through discrete time systems.

7. Control System

Fundamental of control systems, block diagram algebra, Signal flow graph and Mason's gain formulae, Linear-time invariant (LTI) systems; Time-domain and frequency-domain response.Proportional, Propotional-integral (PI) and Proportion-integral-derivative (PID) control strategies. Stability analysis; Routh-Hurwitz criterion, Nyquist criterion, Design of lead-lag compensators, State space models, Controllability and observability.Principles of discrete Control systems.

8. Microprocessors and Microcomputers

8 bit microprocessor 8085: Architecture, instructions set, CPU, module design, memory interfacing and I/O, interrupts, PPI 8255.

9. Electromechanical energy conversion , Industrial Drives and Utilisation

Principles of electromechanical energy conversion, Torque and electromotive force (EMF) in rotating machines, characteristics and performance analysis of DC machines and their stating and speed control. Transformers: Principles of operation and analysis, regulation, Three-phase transformer, Three-phase induction machines, and Synchronous machines: Their characteristics and performance analysis, speed control. Special machines: Stepper motors, Brushless DC motors, Switched reluctance motors, Permanent magnet motors, Single phased induction motor (fractional-horsepower motor (FHP) motors): Performance and analysis.

Basic concepts of speed control DC and AC motor drives. Applications of variable speed drives V/f control, Quadrant operation of drives, Concept of cycloconverts and Dual converts fed AC and DC drive.

Rating andcharacteristic of traction motors, dielectric, and induction heating.

10. Power Systems Analysis and Control , Switch gear and protection

Performance evaluation of overhead transmission lines and cables, fundamentals of active and reactive power transfer, voltage control and power factor correction, Bus admittance and impedance matrices, Load flow study, Economic operation of power system, Symmetrical components, Analysis of symmetrical and unsymmetrical faults, concept of stability, swing curve and equal area criterion, static volt-ampere reactive (VAR) systems, basic concepts of high voltage direct current (HVDC) transmission, series and shunt compensation, flexible alternating current transmission systemFACTS, speed control of generators, tie line control and frequency control.

Principle of over current, differential and distance protection, concept of solid state relays and circuit breakersof various protection schemes for transmission lines, generator and transformer. Protection against surges.