(UPSC Syllabus)
Part A - Preliminary Examination - Optional Subjects
Examination Syllabus - Subject : Electrical Engineering

(For both objective and conventional type papers)

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.

Signals & Systems

Representation of continuous-time and discrete-time signals & system's; 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.

Control Systems

Elements of control systems; block-diagram representations; open-loop & closed-loop systems; principles and applications of feed-back. LTI systems: time domain and transform domain analysis. Stability: Routh Hurwitz criterion, root-loci, Nyquist's criterion. Bode-plots, Design of lead-lag compensators; Proportional, PI, PID controllers.

E.M. Theory

Electro-static and magneto-static fields; Maxwell's equations; e.m. waves and wave equations; wave propagation and antennas; transmission lines; micro-wave resonators, cavities and wave guides.

Electrical Engineering Materials

Electrical/electronic behaviour of materials : conductivity; free-electrons and band-theory; intrinsic and extrinsic semi-conductor, p-n junction; solar cells, super-conductivity. Dielectric behaviour of materials: polarization phenomena; piezo-electric phenomena. Magnetic materials: behaviour and application.

Analog Electronics

Diode circuits: rectifiers filters, clipping and clamping, zener diode and voltage regulation. Bipolar and field effect transistors (BJT, JFET and MOSFET): Characteristics, biasing and small signal equivalent circuits. Basic amplifier circuits; differential amplifier circuits. Amplifiers : analysis, frequency response. Principles of feedback; OPAMP circuits; filters; oscillators.

Digital Electronics

Boolean algebra; minimisation of Boolean function; logic gates, digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoder's. Sequential circuits: latches and flip-flops, counters and shift-registers. Comparators, timers, multivibrators. Sample and hold circuits; ADCs and DACs. Semiconductor memories.

Communication Systems

Fourier analysis of signals: amplitude, phase and power spectrum, auto-correlation and cross-correlation and their Fourier transforms. Analog modulation systems: amplitude and angle modulation and demodulation systems, spectral analysis; superheterodyne receivers. Pulse code modulation (PCM), differential PCM, delta modulation. Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK). Multiplexing: time-division, frequency-division. Additive Gaussian noise: characterization using correlation, probability density function, power spectral density, Signal-to-noise ratio calculations for AM and FM. Elements of digital communication systems: source coding, channel coding; digital modulation & demodulation. Elements of Information theory, channel capacity. Elements of satellite and mobile communication; principles of television engineering; radar engineering and radio aids to navigation.

Computers and Microprocessors

Computer organization: number representation and arithmetic, functional organization, machine instructions, addressing modes, ALU, hardwired and microprogrammed control, memory organization. Elements of microprocessors: 8-bit microprocessors -architecture, instruction set, assembly level programming, memory, I/O interfacing, microcontrollers and applications.

Measurement and Instrumentation

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

Energy Conversion

Single-phase transformer: equivalent circuit, phasor-diagram, tests, regulation and efficiency; three-phase transformer; auto transformer. Principles of energy conversion-d.c. generators and motors: Performers characteristics, starting and speed control armature reaction and commutation; three-phase induction motor; performance characteristics, starting and speed control. Single-phase induction motor. Synchronous generators: performance characteristics, regulation, parallel operation. Synchronous motors: starting characteristics, applications; synchronous condenser. FHP motors, permanent magnet and stepper motors, brushless d.c. motors, single-phase motors.

Power Systems

Electric power generation: thermal, hydro, nuclear. Transmission line parameters: steady-state performance of overhead transmission lines and cables. Distribution systems: insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction. Economic operation. Principles of over current, differential and distance protection; solid state relays, circuit breakers, concept of system stability. HVDC transmission.

Power Electronics and Electric Drives

Semiconductor power devices: diode, transistor, thyristor, triac, GTO and MOSFET, static characteristics, principles of operation; triggering circuits; phase controlled rectifiers; bridge converters-fully controlled and half controlled; principles of thyristor chopper and inverter. Basic concept of speed control of DC and AC motor drives.

Elements of IC Fabrication 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, silicon-nitride and silicon dioxide; metallisation and passivation.