UPSC CSE Electrical Engineering Syllabus 2024

The UPSC Electrical Engineering syllabus covers the fundamentals of electrical circuits, signal processing, microprocessors, programming, power systems, machines, high voltage engineering, analog and digital electronics, control systems, and communication. Questions will test conceptual knowledge and analytical abilities. Aspirants are expected to apply engineering concepts to governance, policymaking and real-world issues. The exam will evaluate problem-solving skills, logical reasoning and data interpretation capabilities.

UPSC CSE Electrical Engineering Syllabus 2024 Paper 1

1. Circuits—Theory:

- 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
- Coupled circuits
- Balanced 3-phase circuits
- Two-port networks

2. Signals and Systems:

- Representation of continuous-time and discrete-time signals and systems
- 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 lines: travelling and standing waves, impedance matching, Smith chart

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
- Frequency-response of amplifiers
- OPAMP circuits
- Filters
- Sinusoidal oscillators
- Function generators and wave-shaping circuits
- Linear and switching power supplies

5. Digital Electronics:

- Boolean algebra
- Minimization 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
- Logic implementation using programmable devices (ROM, PLA, FPGA)

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 and synchronous machines: characteristics and performance analysis; speed control

7. Power Electronics and Electric Drives:

- Semiconductor power devices: diode, transistor, thyristor, triac, GTO, and MOSFET-static characteristics and principles of operation; triggering circuits
- Phase control rectifiers
- Bridge converters: fully-controlled and half-controlled
- Principles of thyristor choppers and inverters
- DC-DC converters

- Switch mode inverter
- Basic concepts of speed control of dc and ac motor drives applications of variable-speed drives

8. Analog Communication:

- Random variables: continuous, discrete; probability, probability functions
- Statistical averages; probability models
- Random signals and noise: white noise, noise equivalent bandwidth; signal transmission with noise; signal to noise ratio
- Linear CW modulation: Amplitude modulation: DSB, DSB-SC, and SSB
- Modulators and Demodulators; Phase and Frequency modulation: PM & FM signals; narrowband FM; generation & detection of FM and PM, Deemphasis, Preemphasis
- CW modulation system: Superheterodyne receivers, AM receivers, communication receivers, FM receivers, phase-locked loop, SSB receiver
- Signal to noise ratio calculation for AM and FM receivers

UPSC CSE Electrical Engineering Syllabus 2024 Paper 2

1. Control Systems:

- Elements of control systems
- Block-diagram representations
- Open-loop & closed-loop systems
- Principles and applications of feedback
- Control system components
- LTI systems: time-domain and transform-domain analysis
- Stability: Routh Hurwitz criterion, root-loci, Bode-plots, and polar plots, Nyquist's criterion
- Design of lead-lag compensators
- Proportional, PI, PID controllers
- State-variable representation and analysis of control systems

2. Microprocessors and Microcomputers:

- PC organization
- CPU, instruction set, register set, timing diagram, programming, interrupts
- Memory interfacing
- I/O interfacing
- Programmable peripheral devices

3. Measurement and Instrumentation:

- Error analysis
- Measurement of current, voltage, power, energy, power-factor, resistance, inductance, capacitance, and frequency
- Bridge measurements
- Signal conditioning circuits

- Electronic measuring instruments: multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyzer, distortion-meter
- Transducers: thermocouple, thermistor, LVDT, strain-gauge, piezoelectric crystal

4. Power Systems: Analysis and Control:

- Steady-state performance of overhead transmission lines and cables
- Principles of active and reactive power transfer and distribution
- Per-unit quantities
- Bus admittance and impedance matrices
- Load flow
- Voltage control and power factor correction
- Economic operation
- Symmetrical components, analysis of symmetrical and unsymmetrical faults
- Concepts of system stability: swing curves and equal area criterion
- Static VAR system
- Basic concepts of HVDC transmission

5. Power System Protection:

- Principles of overcurrent, differential, and distance protection
- Concept of solid-state relays
- Circuit breakers
- Computer-aided protection: introduction; line, bus, generator, transformer protection
- Numeric relays and application of DSP to protection

6. Digital Communication:

- Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM)
- Digital modulation and demodulation schemes: amplitude, phase, and frequency keying schemes (ASK, PSK, FSK)
- Error control coding: error detection and correction, linear block codes, convolution codes
- Information measure and source coding
- Data networks, 7-layer architecture