

## **UPSC Electrical Engineering Optional Syllabus For IAS Mains**

The UPSC Electrical Engineering Optional Syllabus is divided into two papers, i.e., Paper 1 and Paper 2. Candidates should check the topic-wise UPSC Electrical Engineering syllabus for main optional papers 1 and 2 and create their study plan for their preparation journey accordingly.

### **UPSC Electrical Engineering Syllabus for Paper 1**

The UPSC Electrical Engineering Paper I syllabus covers topics like Circuit Theory, Signals and Systems, E.M. Theory, Analog Electronics, Digital Electronics, Energy Conversion, etc. Check the topic-wise UPSC Electrical Engineering Optional Syllabus for Paper I below.

#### **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: criterion for oscillation; single-transistor and OPAMP

configurations. Function generators and wave-shaping circuits. Linear and switching 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. 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, DSBSC and SSB. Modulators and Demodulators; Phase and Frequency modulation: PM & FM signals; narrow band 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 Electrical Engineering Syllabus for Paper 2**

The UPSC Electrical Engineering Paper II Syllabus focuses on topics like Control Systems, Microprocessors and Microcomputers, Measurement and Instrumentation, Power

Systems, and Digital Communication. Check the topic-wise UPSC Electrical Engineering Optional Syllabus PDF for Paper II below.

#### 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 organisation; 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 circuit; Electronic measuring instruments: multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyser, distortion-meter. Transducers: thermocouple, thermistor, LVDT, strain-gauge, piezo-electric 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.

