

Maharashtra Public Service Commission**Civil Services Exam – Mains Optional****Electrical Engineering****(Code No : 405)****Paper - I****Standard** : : Degree in Electrical Engineering**Total Marks** : 200**Nature of Paper** : Conventional Type**Duration** : 3 Hours

- Note :**
- 1) Answers to this paper must be written in English only
 - 2) This paper will test the candidate's ability to comprehend, to analyse, to interpret, to criticise and to appraise subject matter related to the topics/sub topics mentioned below.
 - 3) For judging candidates' conceptual understandings, appropriate numbers of numerical problems will be asked.
 - 4) It is expected from candidates to study the latest and recent developments and happenings pertaining to the topics/sub topics mentioned below.

Section - A (Marks : 50)**Electrical Fundamentals and Machines****1) Basics and Circuit Theory :**

- .01)** Work, Power, Energy; Ohm's law; DC circuits; Kirchoff's laws; AC circuits, Resonance in R-L-C circuits.
- .02)** Nodal analysis; Mesh analysis; Network theorems; Transient analysis of RL, RC and RLC circuits; 3 phase circuits; Two-port networks, Circuit simulation using software packages such as SPICE, MATLAB etc.
- .03)** Maxwell's equations; Wave propagation in bounded media; Boundary conditions; Reflection and refraction of plane waves; Transmission line; Distributed parameter circuits; Traveling and standing waves.

2) Electrical Machines :

- .01) DC Machines :** Construction, Working principle, Characteristics and applications; Starting and speed control.
- .02) AC Machines:** Single phase and poly phase induction motors. Synchronous motor-construction, working principle and characteristics, starting and speed control; FHP motors and stepper motors, Alternators- Basics and Parallel operation.
- .03) Power and Distribution Transformers:** Design, Efficiency and regulation by direct and indirect loading; Types of transformer connections.

Section - B (Marks : 50)**Electrical Measurements and Control****3) Electrical Measurements :**

- .01)** Measurement of current, voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency.
- .02)** Multimeters, CRO, digital voltmeter, frequency counter, Q-meter, megger, earth tester, potentiometer.

- .03) **Transducers:** thermocouple, thermistors, LVDT, strain guage, piezo-electric crystal; Use of transducers in measurement of non-electrical quantities, Data acquisition systems.
- 4) **Control Engineering :**
- .01) Block diagram representation; Principles and applications of feedback.
- .02) **LTI systems:** Time-domain and transform-domain analysis; Routh-Hurwitz criterion; Root Loci; Nyquist criterion, Bode plots.
- .03) Design of lead-lag compensators; P, PI, PID controllers; State variable representation; Principles of discrete control systems.

Section - C (Marks : 50)

Electrical Power Systems

- 5) **Power Systems :**
- .01) Steady-state performance of overhead transmission lines and cables; Per unit quantities; Bus admittance and impedance matrices; Symmetrical components;
- .02) Analysis of symmetrical and unsymmetrical faults; Principle of active and reactive power transfer and distribution, Reactive power compensation.
- .03) Principles of circuit breaking; Arc extinction for DC and AC; Arc interruption theories; Duties of switchgear; Various types of circuit breakers and their applications to power systems; Specifications of an impulse voltage wave; Standard impulse; Multi-stage impulse generator; Insulation co-ordination; Principles of overcurrent, differential and distance protection; Concept of solid-state relays; Computer-aided protection; Protection of generators, transformers and transmission lines; Application of DSP to protection.
- 6) **Computer aided power systems :**
- .01) Static VAR systems; Concept of HVDC transmission; FACTS devices such as SVC & UPFC.
- .02) Introduction to load dispatch centers (LDC); SCADA systems; Speed control of generators; Tie-line control; Frequency control; Economic dispatch.

Section - D (Marks : 50)

Electronics

- 7) **Analog electronics :**
- .01) Characteristics and equivalent circuits of diode, BJT, JFET and MOSFET; Clipping, clamping and rectifier circuits using diodes; Biasing and bias stability, FET amplifiers.
- .02) Single and multi-stage, differential, operational, feedback and power amplifiers; Analysis of amplifier; Frequency response of amplifiers; OPAMP circuits; Filters; Function generation; Wave shaping circuits; Power supplies.
- 8) **Digital electronics :**
- .01) Boolean algebra; minimization of boolean functions; Logic gates; Digital IC families; Combinational circuits; Arithmetic circuits; Code converters; Multiplexers; Decoders.
- .02) Latches and flip-flops; Counters and shift registers; Comparators; Timers; Multi-vibrators; Sample and hold circuits; ADCs and DACs; Semiconductor memories; Logic implementation using ROM, PLA & FPGA.

Paper - II**Standard :** Degree in Electrical Engineering**Total Marks :** 200**Nature of Paper :** Conventional Type**Duration :** 3 Hours

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Section - A (Marks : 50)**Power Electronics and Micro-controllers**

- 1) **Power Electronics and Electrical Drives :**
 - .01) Diodes, Power transistors, thyristors, triacs, GTOs, MOSFETs, IGBTs - Static characteristics and principle of operation; Triggering circuits; Phase controlled rectifiers; Bridge converters - fully controlled and half controlled.
 - .02) Principles of choppers, inverters and cyclo-converters; Basic concepts of speed control of dc and ac motors drives; Applications of variable speed drives.
- 2) **Micro-processors and Micro-controllers :**
 - .01) Evolution of microprocessor technology, 8085 CPU; Architecture, programming, memory & I/O interfacing.
 - .02) 8051 Micro-controller - Architecture, memory organization, addressing modes, instruction set, boolean processing, simple programmes; Interrupt structures; Timer and serial functions; Parallel port features; Modes of operation; Power control; Interfacing; Typical applications.

Section - B (Marks : 50)**Communication Engineering**

- 3) **Analog and Digital Communication :**
 - .01) Need for modulation; Normal amplitude modulation; Modulation index; Frequency and phase modulation; Frequency deviation and modulation index; Sampling theorem - low pass and band pass; Pulse amplitude modulation; Pulse width modulation; Pulse position modulation.
 - .02) Pulse code modulation; Differential pulse code modulation, Delta modulation; Digital modulation and demodulation schemes; Interfacing with power line; Description of a typical power line carrier communication system.
- 4) **Fibre Optic Systems :**
 - .01) Time division multiplexing; Frequency division multiplexing; Optical properties of materials; Refractive index; Absorption and emission of light.
 - .02) Optical fibres; Lasers and opto-electronic materials; Fibre optic links.

Section - C (Marks : 50)**Signals, Systems and Digital Signal Processing**

- 5) **Signals and Systems :**
 - .01) Representation of continuous-time and discrete-time signals and systems; LTI systems; Convolution; Impulse response.
 - .02) Time-domain analysis of LTI systems based on convolution and differential/difference equations.

- .03)** Fourier transforms; Laplace transforms; Z-transforms; Transfer functions; Sampling and recovery of signals; DFT, FFT processing of analog signals through discrete-time systems.
- 6) Digital Filters :**
- .01)** Frequency domain design of digital filters; Quantization effects in digital filters.
- .02)** High speed convolution and its application to digital filtering; Multi-rate filtering.
- Section - D (Marks : 50)**
- Energy Systems and Stability**
- 7) Energy Management :**
- .01)** Introduction to energy problem; Power scenario of Maharashtra State and India, Difficulties with conventional energy sources; Basics of wind turbine aerodynamics; Wind energy conversion systems and their integration into electrical grid; Power quality issues Solar energy: Thermal conversion, Photovoltaic conversion.
- .02)** Importance of energy management; Energy conservation opportunities, Energy audit; Energy economics; Discount rate; Payback period; Internal rate of return; Life cycle costing, Electricity Act 2003.
- 8) Power System Stability :**
- .01)** System modeling and dynamics of synchronous generators; Small signal stability analysis (Low frequency oscillations) - Analysis of single machine systems, Applications of power system stabilizers, Analysis of multi-machine system.
- .02)** Transient stability analysis; Dynamic stability analysis; Voltage stability analysis; Static VAR control of load.
