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ESE - 2027

UPSC MAINS EXAMINATION



ELECTRICAL ENGINEERING

Previous Years Conventional Questions with
Solutions, Subjectwise & Chapterwise

Paper-II (Conventional)

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Foreword

In UPSC Engineering Services, Conventional Papers have 54.5% weightage in the entire process of written test.

In Paper-II of Electrical Engineering six subjects are included as follows:

- | | |
|-----------------------------------|----------------------------------|
| 1. Analog and Digital Electronics | 2. Systems and Signal Processing |
| 3. Control Systems | 4. Electrical Machines |
| 5. Power Systems | 6. Power Electronics and Drives |



As Systems and Signal Processing is included from ESE-2017, few expected model questions are added in this Booklet.

The following approach is advisable to secure maximum marks.

- The solution to any question shall have the following appropriate steps generally. Steps will also have due weightage.
 - (a) The data given
 - (b) The appropriate figure, if applicable, with parts labeled properly
 - (c) The concept on which the problem is being solved
 - (d) The relevant formulae with standard notations and abbreviations. Incase the paper setter asks to solve the question from the fundamentals, necessary derivations shall be done. Otherwise 70% of marks one has to lose. If the question carries more marks like 10 to 20 marks detailed analysis is compulsory to score high. If the question carries less marks (<8) the formulae with abbreviations and concept may be sufficient. In any case, the assumptions made shall be written clearly while solving a problem.
- The neatness and presentation of solutions will have 5% marks.
- Note that all parts of a question shall be answered together.
- Using short sentences and brevity in expressing the content is appreciated.
- Practice of numerical problems using calculator is very much essential instead of reading merely.
- * **Try to understand and practice the solutions keeping in view QCAB (Questions cum Answer Booklet) format.**

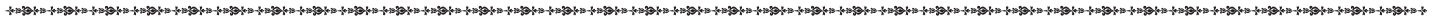
The solutions are prepared with utmost care. In spite of this there may be some typographical mistakes or improper sequence. The student is requested to inform us regarding errors, if any to aceenggpublications@gmail.com. ACE Engineering Publications will be grateful in this regard.

Thanks to all the professors who co-operated in the preparation of this booklet. Thanks to the Academic Assistants and Data Entry section in the design of this booklet.

With best wishes to all those who wish to go through the following pages.

**Y.V. Gopala Krishna Murthy,
M Tech. MIE,
Chairman & Managing Director,
ACE Engineering Academy,
ACE Engineering Publications.
Frost Interactive Service Pvt. Ltd. (ACE ONLINE).**

Syllabus for Electrical Engineering (EE)



- 1. Analog and Digital Electronics:** Operational amplifiers-characteristics and applications, combinational and sequential logic circuits, multiplexers, multi-vibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, simple active filters; Microprocessor basics- interfaces and applications, basics of linear integrated circuits; Analog communication basics, Modulation and demodulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding, frequency and time domain multiplexing, power line carrier communication systems.
- 2. Systems and Signal Processing:** Representation of continuous and discrete-time signals, shifting and scaling operations, linear, time-invariant and causal systems, Fourier series representation of continuous periodic signals, sampling theorem, Fourier and Laplace transforms, Z transforms, Discrete Fourier transform, FFT, linear convolution, discrete cosine transform, FIR filter, IIR filter, bilinear transformation.
- 3. Control Systems:** Principles of feedback, transfer function, block diagrams and signal flow graphs, steady-state errors, transforms and their applications; Routh-hurwitz criterion, Nyquist techniques, Bode plots, root loci, lag, lead and lead-lag compensation, stability analysis, transient and frequency response analysis, state space model, state transition matrix, controllability and observability, linear state variable feedback, PID and industrial controllers.
- 4. Electrical Machines:** Single phase transformers, three phase transformers - connections, parallel operation, auto-transformer, energy conversion principles, DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors, Induction motors - principles, types, performance characteristics, starting and speed control, Synchronous machines - performance, regulation, parallel operation of generators, motor starting, characteristics and applications, servo and stepper motors.
- 5. Power Systems:** Basic power generation concepts, steam, gas and water turbines, transmission line models and performance, cable performance, insulation, corona and radio interference, power factor correction, symmetrical components, fault analysis, principles of protection systems, basics of solid state relays and digital protection; Circuit breakers, Radial and ring-main distribution systems, Matrix representation of power systems, load flow analysis, voltage control and economic operation, System stability concepts, Swing curves and equal area criterion. HVDC transmission and FACTS concepts, Concepts of power system dynamics, distributed generation, solar and wind power, smart grid concepts, environmental implications, fundamentals of power economics.
- 6. Power Electronics and Drives:** Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation, triggering circuits, phase control rectifiers, bridge converters-fully controlled and half controlled, principles of choppers and inverters, basis concepts of adjustable speed dc and ac drives, DC-DC switched mode converters, DC-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

Weightage of Subjects in Engineering Services Examination Electrical Engineering (2022 - 2026)

PAPER - II (Conventional)

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S.No.	Name of the Subject	2022	2023	2024	2025	2026
01	Analog & Digital Electronics	64	72	60	72	84
02	Systems & Signal Processing	72	72	84	72	52
03	Control Systems	84	84	84	84	84
04	Electrical Machines	124	84	94	84	92
05	Power Systems	72	84	84	84	104
06	Power Electronics & Drives	64	84	74	84	64
Total Marks		480	480	480	480	480

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Analog & Digital Electronics

(Previous ESE Questions with Solutions)