**UNION PUBLIC SERVICE COMMISSION, NEW DELHI**

**ENGINEERING SERVICES EXAMINATION (ESE) SYLLABI**

**Branch/Discipline: Electrical Engineering**

**(Contents for syllabi of both the Papers together for Stage-I objective type Paper–II and separately for Stage-II Conventional type Paper-I and Paper – II)**

**PAPER – I**

**1.  Engineering Mathematics**

Matrix theory, Eigen values & Eigen vectors, system of linear equations, Numerical methods for solution of non-linear algebraic equations and differential equations, integral calculus, partial derivatives, maxima and minima, Line, Surface and Volume Integrals. Fourier series, linear, non-linear and partial differential equations, initial and boundary value problems, complex variables, Taylor’s and Laurent’s series, residue theorem, probability and statistics fundamentals, Sampling theorem, random variables, Normal and Poisson distributions, correlation and regression analysis.

**2. Electrical Materials**

Electrical Engineering Materials, crystal structures and defects, ceramic materials, insulating materials, magnetic materials – basics, properties and applications; ferrities, ferro-magnetic materials and components; basics of solid state physics, conductors; Photo-conductivity; Basics of Nano materials and Superconductors.

**3. Electric Circuits and Fields**

Circuit elements, network graph, KCL, KVL, Node and Mesh analysis, ideal current and voltage sources, Thevenin’s, Norton’s, Superposition and Maximum Power Transfer theorems, transient response of DC and AC networks, Sinusoidal steady state analysis, basic filter concepts, two-port networks, three phase circuits, Magnetically coupled circuits, Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions, Ampere’s and Biot-Savart’s laws; inductance, dielectrics, capacitance; Maxwell’s equations.

**4. Electrical and Electronic Measurements:**

Principles of measurement, accuracy, precision and standards; Bridges and potentiometers; moving coil, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy and power factor, instrument transformers, digital voltmeters and multi-meters, phase, time and frequency measurement, Q-meters, oscilloscopes, potentiometric recorders, error analysis, Basics of sensors, Transducers, basics of data acquisition systems

**5. Computer Fundamentals:**

Number systems, Boolean algebra, arithmetic functions, Basic Architecture, Central Processing Unit, I/O and Memory Organisation; peripheral devices, data represenation and programming, basics of Operating system and networking, virtual memory, file systems; Elements of programming languages, typical examples.

**6. Basic Electronics Engineering:**

Basics of Semiconductor diodes and transistors and characteristics, Junction and field effect transistors (BJT, FET and MOSFETS), different types of transistor amplifiers, equivalent circuits and frequency response; oscillators and other circuits, feedback amplifiers.

**PAPER – II**

**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 de-modulation, 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.

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| --- | --- | --- | --- | --- | --- |
| Preliminary  Examination | **Paper - I** | **Objective** | General Studies  &  Engineering Aptitude | **2 hours** | **200 marks** |
| **Paper - II** | **Objective** | Engineering  Discipline | **3 hours** | **300 marks** |
| Mains  Examination | **Paper - I** | **Conventional** | Engineering  Discipline - I | **3 hours** | **300 marks** |
| **Paper - II** | **Conventional** | Engineering  Discipline - II | **3 hours** | **300 marks** |

Books that should be read

|  |  |  |  |
| --- | --- | --- | --- |
| S.No. | Subject | Book Name | Author |
| 1 | Power Electronics & Drives | MADE  EASY  SERIES :  Power Electronics | MADE EASY PUBLICATIONS |
| Power Electronics | P.S. Bhimbra |
| 2 | Micro Processors | MADE EASY SERIES :   Microprocessors | MADE EASY PUBLICATIONS |
| Micro Processors for theory portion | Gaonkar |
| Micro Processors for Programming examples | B. Ram |
| 3 | Analog & Digital Electronics | MADE EASY SERIES :  Analog Electronics | MADE EASY PUBLICATIONS |
| Analog & Digital Electronics | Millman&Halkias |
| Analog & Digital Electronics | Gayakwad |
| Analog & Digital Electronics | Morris Mano |
| Analog & Digital Electronics for Digital Logic Families | Taub&Shielling |
| 4 | Power Systems | MADE EASY SERIES :   Power Systems | MADE EASY PUBLICATIONS |
| Power Systems | Nagrath & Kothari |
| Power Systems | C.L. Wadhwa |
| Power Systems | A. Hussain |
| 5 | Electrical Machines and Power Transformers | MADE EASY SERIES :    Electrical Machines | MADE EASY PUBLICATIONS |
| Electrical Machines and Power Transformers | P.S. Bhimbra |
| Electrical Machines and Power Transformers | Nagrath& Kothari |
| 6 | Control Systems | MADE EASY SERIES :  Control Systems | MADE EASY PUBLICATIONS |
| Control System Engg. | I.J. Nagrath& M. Gopal |
| Automatic Control Systems | B.C. Kuo |
| Linear Control Systems | B.S. Manke |
| 7 | Electrical & Electronics  Measurement | MADE EASY SERIES :  Measurement & Instrumentation | MADE EASY PUBLICATIONS |
| Measurement & Instrumentation | A. K. Sawhney |
| Measurement & Instrumentation | Cooper |
| 8 | Electrical Circuits | MADE EASY SERIES :   Electrical Circuits | MADE EASY Publications |
| Electrical Circuits for Resonant Circuits, elements of two element network synthesis, etc | D-Roy Chaudhary |
| Electrical Circuits for transfer function of n/w in terms of poles and zeros | SudhakarShyam Mohan |
| Electrical Circuits for Circuit elements, Kirchhoff' Law, Mesh and Nodial Analysis, Network Theorem & Applications | Chakrabarthy |
| 9 | E. M. Theory | MADE EASY SERIES :   E. M. Theory | MADE EASY Publications |
| E. M. Theory for coulombs law, Gauss's Law, Conductors etc. | W. B. Hayt |
| E. M. Theory for Magneto statics, Amperes law, Magnetic materials | Sadiku |
| E. M. Theory for Numerical examples | Schaum Series |
| 10 | Signal and System | MADE EASY SERIES :   Signal and System | MADE EASY Publications |
| Signal and System | Oppenheim and Willsky |
| 11 | Engg. Mathematics | Engg. Mathematics | MADE EASY Publications |
| 12 | Verbal & Numerical Ability | Verbal & Numerical Ability | MADE EASY Publications |
| 13 | Previous GATE Solved Papers | Previous GATE Solved Papers | MADE EASY Publications |
| 14 | Analog Circuits | A text book on Analog Circuits | A.Rajkumar |
| 15 | Digital Electronics | MADE EASY SERIES :   Digital Electronics | MADE EASY PUBLICATIONS |
| 16 | Power System | MADE EASY SERIES :   Power System | MADE EASY PUBLICATIONS |
| 17 | Communications System | MADE EASY SERIES : Communications System | MADE EASY PUBLICATIONS |
| 18 | Other References | GATE 2016 : Electrical Engg. Solved Papers | MADE EASY PUBLICATIONS |
| A handbook of Electrical Engg.  Engineering | MADE EASY PUBLICATIONS |

Paper-I

1. [Electro Magnetic Theory](http://onlineies.com/)

Book: Hayt upto Maxwell Equations, and Jordan & Ballman after Maxwells Equations. For problems one may depend on Hayt solutions or Sadiku.

For objective: We may expect around 15 questions from this area. Out of which questions from Transmission lines cover least 4 questions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 21 | 20 | 18 | 15 | 14 | 15 |

For Descriptive: For this they decreased importance from past years. We can expect around 30 to 40 marks from this area. So, we have to study this subject least important topics.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 72 | 50 | 32 | 32 | 40 | 30 |

2. [Electrical Materials](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: Only one book is sufficient for this. Indulkar is enough in all the ways.

For Objective: By seeing below we can expect around 10 to 15 questions from this area.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 14 | 20 | 20 | 16 | 14 | 15 |

For Descriptive: By seeing below table we can say that, we have to study this subject fully and solve complete example problems from Indulkar book.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 68 | 70 | 72 | 72 | 74 | 60 |

3. [Network Theory](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: 3000 solved problems by Schaum’s series for problems for Descriptive.

Hayt and Kemmerly upto second order transients

Chakrabarthi book for Theorems

V V Berg for Remaining topics.

For Objective: By seeing the following table we can expect around 20 to 25 questions from this subject.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 25 | 20 | 19 | 18 | 23 | 25 |

For Descriptive: By seeing the following table we can say that, importance is increasing. So, we should not leave this subject.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 22 | 50 | 72 | 72 | 72 | 60 |

4. [Measurements](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: AK Sawhney for Electrical Measurements and Kalsi for Electronic Instrumentation.

For Objective: By seeing the following table we can expect around 30 questions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 29 | 30 | 30 | 28 | 33 | 32 |

For Descriptive: This subject is very important as its carrying almost 50% of weightage in first paper. At any cost we should not leave even a single topic also from this area.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 108 | 90 | 96 | 96 | 86 | 90 |

5. [Control Systems](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: Nagrath and Gopal for Theory and Nagoorkani for problems.

For Objective: We can expect around 40 questions from this area. We should not leave formulae based problems in this subject.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 31 | 30 | 33 | 42 | 36 | 38 |

For Descriptive:Importance for this subject is being increased.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 32 | 40 | 64 | 64 | 64 | 60 |

All over except EMF every other subject is important for Descriptive paper.

Paper-II:

1.[Electrical Machines](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: PS Bimbra for all the topics and example problems.

Nagrath & Kothari for 3phase transformers, 3 winding transformers, Basic concepts related to co-energy, field energy etc.,

BL Theraja- for 1-phase machines.

For Objective: For any Electrical Engineer for any competitive exam, this subject is a must to prepare.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 32 | 30 | 31 | 29 | 30 | 31 |

For Descriptive: This subject is very important and at any cost we should not leave this subject. By observing below table we can say AC machines are more important than DC machines.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 2005 | 2006 | 2007 | 2008 | 2009 |
| AC machines | 78 | 58 | 40 | 41 | 52 |
| DC machines | 12 | 8 | 16 | 21 | 12 |

2. [Power Systems](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation): This is also very important subject and must read for any electrical engineer. Books: CL Wadhwa –Load flows, z-bus formation, part of protection, Problems related to Generating Stations.

Nagrath& Kothari-Stability, Fault analysis, Economic load dispatch, Transients on Power Systems, L,C parameter calculations and finding performance of Tr., lines.

VK Mehta- Generation, Distribution.

BadriRam for Protection.

For Objective: We can expect around 20 questions from this area.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 21 | 19 | 24 | 18 | 16 | 18 |

For Descriptive:Here by seeing the table u may conclude that, importance for protection part is reduced and need not be prepared which is NOT correct. We have to prepare each and every topic in Power Systems.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 18 | 30 | 28 | 41 | 20 | 32 |
| 70 | 28 | 2 | 55 | 32 | 30 |
| 0 | 4 | 28 | 15 | 29 | 10 |
| 10 | 34 | 2 | 13 | 27 | 0 |

3. [Analog and Digital Electronics](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: Morris Mano for Digital Electronics Theory

RP Jain for problems in Digital Electronics.

Boyelsted for Analog Electronics.

Objective: We can expect around 30 questions from this.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 25 | 22 | 30 | 30 | 26 | 28 |

Descriptive: For a typical Electrical Engineer, Analog may be a bit difficult (Frankly alien) subject. One can leave Analog after studying old question paper questions and important topics. But Digital Electronics should be studied.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 2004 | 2005 | 2006 | 2007 | 2008 |
| Analog | 24 | 46 | 46 | 14 | 12 |
| Digital | 4 | 42 | 36 | 30 | 30 |

4. [Microprocessor](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Books: Goankar is enough. Especially Instruction set is important here along with machine cycles and t-states for each instruction.

Objective: We can expect 15 to 20 questions this year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 13 | 14 | 10 | 17 | 18 | 15 |

Descriptive: This subject can be removed from the seriously preparing topics for Descriptive.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 38 | 40 | 42 | 32 | 30 | 34 |

4. [Communication Systems](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation):

Books: Only one book George Kennedy is enough with all example problems.

Objective: We can expect around 15 questions from this area.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 14 | 15 | 14 | 15 | 16 | 15 |

For Descriptive: In this area, especially analog Communication part is more important than digital. We may leave Digital Electronics for both Objective and Descriptive.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 30 | 40 | 44 | 32 | 30 | 32 |

5. [Power Electronics](http://www.onlineies.com/free-downloads-gate-ies-psus-preparation)

Book: PS Bimbra for all topics in Power Electronics and For Drives GK Dubey.

Objective: We can expect around 15 questions from Power Electronics and Drives. Power Electronics part is more important than Drives for Objective.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 15 | 14 | 11 | 12 | 14 | 15 |

Descriptive: Here we may leave AC drives part without loosing DC Drives. Plus power electronics part need to be studied.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| 59 | 70 | 44 | 40 | 46 | 36 |