

## Engineering Services Examination 2021 Exam Pattern & Syllabus

### IES 2021 Examination Structure

#### 1. The examination shall be conducted according to the following plan :-

(i) Stage-I : Engineering Service (Preliminary / Stage-I) Examination (Objective Type Papers) for the selection of candidates for the Stage-II: Engineering Service (Main/Stage-II) Examination;

(ii) Stage-II : Engineering Service (Main / Stage-II) Examination (Conventional Type Papers and

(iii) Stage-III : Personality Test.

2. The Engineering Service (Preliminary / Stage-I) Examination will consist of two objective type (multiple choices) questions papers and carrying a maximum of 500 marks (Paper I – 200 Marks & Paper II – 300 Marks). Only those candidates who are declared by the Commission to have qualified in the Preliminary / Stage-I Examination in the year will be eligible for admission to the Main / Stage - Preliminary /Stage-I Examination by the candidates who are declared qualified for admission to the Main / Stage-II Examination of that year provided they are otherwise eligible for admission to the Main / Stage-II Examination. The Marks obtained in Preliminary / Stage-I Examination by the candidates who are declared qualified for admission to the Main / Stage-II Examination will be counted for determining their final order of merit. The number of candidates to be admitted to the Main / State-II Examination will be about six to seven time the total approximate number of vacancies to be filled in the year through this examination.

**Note I :** The Commission will draw a list of candidates to be qualified for Engineering Service (Main / Stage-II) Examination based on the criterion of minimum qualifying marks in General Studies and Engineering Aptitude Paper (Paper-I) and Engineering Discipline specific paper (Paper-II) of Preliminary / Stage-I Examination.

**Note II :** There will be penalty (Negative Marking) for wrong answers marked by a candidate in the objective type question papers.

(i) There are four alternative for the answers to every question. For each question for which a wrong answer has been given by the candidates, one-third ( $1/3$ rd) of the marks assigned to that question will be deducted as penalty.

(ii) If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happen to be correct and there will be same penalty as above for that question.

(iii) If a question is left blank i.e. no answer is given by the candidate, there will be no penalty for that question.

3.1 The Engineering Services (Main / Stage-II) Examination will consist two conventional type papers in Engineering Discipline specific with duration of three hours and maximum marks of 600 (300 Marks in each paper).

3.2 The Stage-III will consist of Personality Test carrying 200 Marks.

4.1 Candidates who obtain such minimum qualifying marks in the Stage-I : Engineering Service (Preliminary / Stage-I) and Stage-II : Engineering Services (Main / Stage-II) Examination as may be fixed by the Commission as per its discretion, shall be summoned by them for Stage-III (Personality Test). The number of candidates to be summoned for Personality Test will be about twice the number of vacancies to be filled. The Personality Test will carry 200 marks (with no minimum qualifying marks).

4.2 Marks obtained by the candidates in the Stage-I : (Preliminary / Stage-I) Examination, Stage-II : (Main / Stage-II) Examination and Stage-III (Personality Test) would determine their final ranking. Candidates will be allotted to the various services keeping in view their ranks in the examinations and the preferences expressed by them for the various services / posts.

5. Candidates are advised to read carefully special instructions to candidates for conventional type tests and objective type tests given in Appendix-III (Part A and Part B) including the procedure regarding filling in the Answer Sheet of objective type tests in the Examination Hall uploaded on the Commission's website ([www.upsc.gov.in](http://www.upsc.gov.in)) on 04.07.2021.

6. In the Personality Test special attention will be paid to assessing the candidate's capacity for leadership, initiative and intellectual curiosity, tact and other social qualities, mental and physical energy, powers of practical application and integrity of character.

7. Conventional papers must be answered in English. Question paper will be set in English only.

8. Details of the syllabi for Stage-I: (Preliminary / Stage-I) and Stage-II : (Main / Stage-II) are at Section III.

## SECTION – I

A. Stage-I (Preliminary / Stage-I) Examination :-

The Examination shall comprise of two papers

Subject	Duration	Maximum Marks
<b>Category – I Civil Engineering</b>		
<b>Paper – I (General Studies &amp; Engineering Aptitude)</b>	<b>2 Hrs</b>	<b>200</b>
<b>Paper – II (Civil Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>500</b>

Subject	Duration	Maximum Marks
<b>Category – II Mechanical Engineering</b>		
<b>Paper – I (General Studies &amp; Engineering Aptitude)</b>	<b>2 Hrs</b>	<b>200</b>
<b>Paper – II (Mechanical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>500</b>

Subject	Duration	Maximum Marks
<b>Category – III Electrical Engineering</b>		
<b>Paper – I (General Studies &amp; Engineering Aptitude)</b>	<b>2 Hrs</b>	<b>200</b>
<b>Paper – II (Electrical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>500</b>

Subject	Duration	Maximum Marks
<b>Category – IV Electronics &amp; Telecommunication Engineering</b>		
<b>Paper – I (General Studies &amp; Engineering Aptitude)</b>	<b>2 Hrs</b>	<b>200</b>
<b>Paper – II (Electronics &amp; Telecommunication)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>500</b>

Details of the syllabi are indicated in Section III.

#### **B. Stage-II (Main / Stage-II) Examination :-**

The Examination shall comprise of two papers.

Subject	Duration	Maximum Marks
<b>Category – I Civil Engineering</b>		
<b>Paper – I (Civil Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Paper – II (Civil Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>600</b>

Subject	Duration	Maximum Marks
<b>Category – II Mechanical Engineering</b>		
<b>Paper – I (Mechanical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Paper – II (Mechanical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>600</b>

Subject	Duration	Maximum Marks
<b>Category – III Electrical Engineering</b>		
<b>Paper – I (Electrical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Paper – II (Electrical Engineering)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>600</b>

Subject	Duration	Maximum Marks
<b>Category – IV Electronics &amp; Telecommunication Engineering</b>		
<b>Paper – I (General Studies &amp; Engineering Aptitude)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Paper – II (Electronics &amp; Telecommunication)</b>	<b>3 Hrs</b>	<b>300</b>
<b>Total</b>		<b>500</b>

**(C) Stage-III (Personality Test) - 200 Marks.**

Note : Candidates must write the papers in their own hand. In no circumstances will they be allowed the help of a scribe to write the answers for them. However, blind candidates and candidates with Locomotor Disability and Cerebral Palsy where dominant (writing) extremity is affected to the extent of slowing the performance of function (minimum of 40% impairment) will be allowed to write Engineering Services Examination with the help of a scribe.

Compensatory time of twenty minutes per hour shall be permitted for the blind candidates with Locomotor Disability and Cerebral Palsy where dominant (writing) extremity is affected to the extent of slowing the performance of function (minimum of 40% impairment) will also be allowed in the Engineering Services Examination.

2. The Commission have discretion to fix minimum qualifying marks in any or all the papers of the examination.
3. Marks will not be allotted for mere superficial knowledge.
4. Deduction upto five per cent of the maximum marks for the written papers will be made for illegible handwriting.
5. Credit will be given for orderly, effective and exact expression combined with due economy of words in the conventional papers in the examination.
6. In the question papers, wherever required, SI Units will be used.

Note - Candidates will be supplied with standard tables / charts in SI units in the Examination hall for reference purpose, wherever considered necessary.

7. Candidates are permitted to bring and use battery operated pocket calculators for conventional (essay) type papers only. Loaning or inter-changing of calculators in the Examination Hall is not permitted.

It is also important to note that candidates are not permitted to use calculators for answering objective type papers (Test booklets). They should not therefore, bring the same inside the Examination Hall.

8. Candidates should use only International form of Indian numerals (e.g., 1,2,3,4,5 etc.) while answering question papers.

## IES 2020 Standard and Syllabi

The standard of paper in General Studies and Engineering Aptitude (Preliminary Stage-I Examination) will be such as may be expected of an Engineering / Science Graduate. The standard of papers in other subjects will approximately be that of an Engineering Degree Examination of an Indian University. There will be no practical examination in any of the subjects.

### **General Studies and Engineering Aptitude (Preliminary Examination / Stage-I, Paper I, Objective Type, Common to all candidates).**

1. Current issues of national and international importance relating to social, economic and industrial development.
2. Engineering Aptitude covering Logical reasoning and Analytical ability.
3. Engineering Mathematics and Numerical Analysis.
4. General Principles of Design, Drawing, Importance of Safety.
5. Standards and Quality practices in production, construction, maintenance and services.
6. Basics of Energy and Environment: Conservation, environmental pollution and degradation, Climate Change, Environmental impact assessment.
7. Basics of Project Management.
8. Basics of Material Science and Engineering.
9. Information and Communication Technologies (ICT) based tools and their applications in Engineering such as networking, e-governance and technology based education.
10. Ethics and values in Engineering profession.

**Note :** The paper in General Studies and Engineering Aptitude will include Knowledge of relevant topics as many be expected from an engineering graduate, without special study. Questions from all the 10 topics mentioned above shall be set. Marks for each topic may range from 5% to 15% of the total marks in the paper.

## **Civil Engineering**

**Contents for syllabi of both the papers together for Preliminary Examination / Stage-I (Objective type Paper-II) and separately for Main/Stage-II Examination (Conventional type Paper-I and Paper-II).**

### **PAPER – I**

#### **1. Building Materials:**

Stone, Lime, Glass, Plastics, Steel, FRP, Ceramics, Aluminium, Fly Ash, Basic Admixtures, Timber, Bricks and Aggregates: Classification, properties and selection criteria; Cement: Types, Composition, Properties, Uses, Specifications and various Tests; Lime & Cement Mortars and Concrete: Properties and various Tests; Design of Concrete Mixes: Proportioning of aggregates and methods of mix design.

#### **2. Solid Mechanics :**

Elastic constants, Stress, Plane stress, Strains, plane strain, Mohr's circle of stress and strain, Elastic theories of failure, Principal Stresses, Bending, Shear and Torsion.

### **3. Structural Analysis :**

Basics of strength of materials, Types of stresses and strains, Bending moments and shear force, concepts of bending and shear stresses; Analysis of determinate and indeterminate structures; Trusses, beams, plane frames; Rolling loads, Influence Lines, Unit load method & other methods; Free and Forced vibrations of single degree and multi degree freedom system; Suspended Cables; Concepts and use of Computer Aided Design.

### **4. Design of Steel Structures:**

Principles of Working Stress methods, Design of tension and compression members, Design of beams and beam column connections, built-up sections, Girders, Industrial roofs, Principles of Ultimate load design.

### **5. Design of Concrete and Masonry structure:**

Limit state design for bending, shear, axial compression and combined forces; Design of beams, Slabs, Lintels, Foundations, Retaining walls, Tanks, Staircases: Principles of pre-stressed concrete design including materials and methods; Earthquake resistant design of structures; Design of Masonry Structure.

### **6. Construction Practice, Planning and Management:**

Construction - Planning, Equipment, Site investigation and Management including Estimation with latest project management tools and network analysis for different Type of works; Analysis of Rates of various types of works; Tendering Process and Contract Management, Quality Control, Productivity, Operation Cost; Land acquisition; Labour safety and welfare.

## **PAPER – II**

### **1. Flow of Fluids, Hydraulic Machines and Hydro Power:**

#### **(a) Fluid Mechanics, Open Channel Flow, Pipe Flow :**

Fluid properties; Dimensional Analysis and Modeling; Fluid dynamics including flow kinematics and measurements; Flow net; Viscosity, Boundary layer and control, Drag, Lift, Principles in open channel flow, Flow controls, Hydraulic jump; Surges; Pipe networks.

#### **(b) Hydraulic Machines and Hydro power -**

Various pumps, Air vessels, Hydraulic turbines - types, classifications & performance parameters; Power house - classification and layout, storage, pondage, control of supply.

### **2. Hydrology and Water Resources Engineering:**

Hydrological cycle, Ground Water hydrology, Well hydrology and related data analysis; Streams and their gauging; River morphology; Flood, drought and their management; Capacity of Reservoirs.

**Water Resources Engineering :** Multipurpose uses of Water, River basins and their potential; Irrigation systems, water demand assessment; Resources storages and their yields; Water logging, canal and drainage design, Gravity dams, falls, weirs, Energy dissipaters, barrage Distribution works, Cross drainage works and head-works and their design; Concepts in canal design, construction & maintenance; River training, measurement and analysis of rainfall.

### 3. Environment Engineering :

**(a) Water Supply Engineering :** Sources, Estimation, quality standards and testing of water and their treatment, Rural, Institutional and industrial water supply; Physical, chemical and biological characteristics and sources of water, Pollutants in water and its effects, Estimation of water demand; Drinking water Standards, Water Treatment Plants, Water distribution networks.

**(b) Waste Water Engineering :** Planning & design of domestic waste water, sewage collection and disposal; Plumbing Systems. Components and layout of sewerage system; Planning & design of Domestic Waste-water disposal system; Sludge management including treatment, disposal and re-use of treated effluents; Industrial waste waters and Effluent Treatment Plants including institutional and industrial sewage management.

**(c) Solid Waste Management :**

Sources & classification of solid wastes along with planning & design of its management system; Disposal system, Beneficial aspects of wastes and Utilization by Civil Engineers.

**(d) Air, Noise pollution and Ecology:**

Concepts & general methodology.

### 4. Geo-technical Engineering and Foundation Engineering :

**(a) Geo-technical Engineering :** Soil exploration - planning & methods, Properties of soil, classification, various tests and inter-relationships; Permeability & Seepage, Compressibility, consolidation and Shearing resistance, Earth pressure theories and stress distribution in soil; Properties and uses of geo-synthetics.

**(b) Foundation Engineering :** Type of foundations & selection criteria, bearing capacity, settlement analysis, design and testing of shallow & deep foundations; Slope stability analysis, Retaining embankments, Dams and Earth retaining structure: types, analysis and design, Principles of ground modifications.

### 5. Surveying and Geology:

**(a) Surveying :** Classification of surveys, various methodologies, instruments of analysis of measurements of distances, elevation and directions; Field astronomy, Global Positioning System; Map Preparation; Photogrammetry; Remote sensing concepts; Survey Layout for culverts, canals, bridges, road / railway alignment and buildings, Setting out of Curves.

**(b) Geology :** Basic knowledge of Engineering geology & its application in projects.

### 6. Transportation Engineering :

**Highways -** Planning & construction methodology, Alignment and geometric design; Traffic Surveys and Controls; Principles of Flexible and Rigid pavements design.

**Tunneling -** Alignment, methods of construction, disposal of muck, drainage, lighting and ventilation.



**Railways Systems** - Terminology, Planning, designs and maintenance practices, track modernization.

**Harbours** - Terminology, layouts and planning.

**Airports** - Layout, planning & design.

## **Mechanical Engineering**

**Contents for syllabi of both the Papers together for Preliminary Examination / Stage – I (Objective type Paper – II) and separately for Main / Stage – II Examination (Conventional type Paper – I and Paper – II).**

### **PAPER – I**

#### **1. Fluid Mechanics :**

Basic Concepts and Properties of Fluids, Manometry, Fluid Statics, Buoyancy, Equations of Motion, Bernoulli's equation and applications, Viscous flow of incompressible fluids, Laminar and Turbulent flows, Flow through pipes and head losses in pipes.

#### **2. Thermodynamics and Heat transfer :**

Thermodynamic systems and processes; properties of pure substance; Zeroth, First and Second Laws of Thermodynamics; Entropy, Irreversibility and availability; analysis of thermodynamic cycles related to energy conversion: Rankine, Otto, Diesel and Dual Cycles: ideal and real gases; compressibility factor; Gas mixtures.

Modes of heat transfer, Steady and unsteady heat conduction, Thermal resistance, Fins, Free and forced convection, Correlations for convective heat transfer, Radiative heat transfer - Radiation heat transfer coefficient; boiling and condensation, Heat exchanger performance analysis.

#### **3. IC Engines, Refrigeration and Air conditioning :**

SI and CI Engines, Engine Systems and Components, Performance characteristics and testing of IC Engines; Fuels; Emissions and Emission Control, Vapour compression refrigeration, Refrigerants and Working cycles, Compressors, Condensers, Evaporators and Expansion devices, Other types of refrigeration systems like Vapour Absorption, Vapour jet, thermo electric and Vortex tube refrigeration. Psychometric properties and processes, Comfort chart, Comfort and industrial air conditioning, Load calculations and Heat pumps.

#### **4. Turbo Machinery :**

Reciprocating and Rotary pumps, Pelton wheel, Kaplan and Francis Turbines, velocity diagrams, Impulse and Reaction principles, Steam and Gas Turbines, Theory of Jet Propulsion - Pulse jet and Ram Jet Engines, Reciprocating and Rotary Compressors - Theory and Applications.

#### **5. Power Plant Engineering :**

Rankine and Brayton cycles with regeneration and reheat, Fuels and their properties, Flue gas analysis, Boilers, steam turbines and other power plant components like condensers, air ejectors, electrostatic precipitators and cooling towers - their theory and design, types and applications;



**6. Renewable Sources of Energy :**

Solar Radiation, Solar Thermal Energy collection - Flat Plate and focusing collect its their materials and performance. Solar Thermal Energy Storage, Applications - heating, cooling and Power Generation; Solar Photovoltaic Conversion; Harnessing of Wind Energy, Bio-mass and Tidal Energy - Methods and Applications, Working principles of Fuel Cells.

**PAPER – II****7. Engineering Mechanics :**

Analysis of System of Forces, Friction, Centroid and Centre of Gravity, Dynamics; Stresses and Strains - Compound Stresses and Strains, Bending Moment and Shear Force Diagrams, Theory of Bending Stresses - Slope and deflection - Torsion, Thin and thick Cylinders, Spheres.

**8. Engineering Materials :**

Basic Crystallography, Alloys and Phase diagrams, Heat Treatment, Ferrous and Non Ferrous Metals, Non Metallic materials, Basics of Nano-materials, Mechanical properties and Testing, Corrosion prevention and control.

**9. Mechanisms and Machines :**

Types of Kinematics Pair, Mobility, Inversions, Kinematic Analysis, Velocity and Acceleration Analysis of Planar Mechanisms, CAMs with uniform acceleration and retardation, cycloidal motion, oscillating followers; Vibrations - Free and forced vibration of undamped and damped SDOF systems, Transmissibility Ration, Vibration Isolation, Critical Speed of Shafts. Gears - Geometry of tooth profiles, Law of gearing, Involute profile, Interference. Helical, Spiral and Worm Gears, Gear Trains - Simple, Compound and Epicyclic; Dynamic Analysis - Slider - crack mechanisms, turning moment computations, balancing of Revolving & Reciprocating masses, Gyroscopes - Effect of Gyroscopic couple on automobiles, ships and aircrafts, Governors.

**10. Design of Machine Elements :**

Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram principles of the design of machine elements such as riveted, welded and bolted joints, Shafts, Spur gears, rolling and sliding contact bearings, Brakes and clutches, flywheels.

**11. Manufacturing, Industrial and Maintenance Engineering :**

Metal casting-Metal forming, Metal Joining, Machining and machine tool operations, Limits, fits and tolerances, Metrology and inspection, computer Integrated manufacturing, FMS, Production planning and Control, Inventory control and operations research-CPM-PERT. Failure concepts and characteristics-Reliability, Failure analysis, Machine Vibration, Data acquisition, Fault Detection, Vibration Monitoring, Field Balancing of Rotors, Noise Monitoring, Wear and Debris Analysis, signature Analysis, NDT Techniques in Condition Monitoring.

**12. Mechatronics and Robotics:**

Microprocessors and Microcontrollers : Architecture, programming, I/O, Computer interfacing, Programmable logic controller. Sensors and actuators, Piezoelectric accelerometer, Hall effect sensor, Optical Encoder, Resolver, Inductosyn, Pneumatic and Hydraulic actuators, Stepper motor, Control Systems - Mathematical modeling and Physical systems, control signals, controllability and observability. Robotics, Robot

Classification, Robot Specification, notation; Direct and Inverse Kinematics; Homogeneous Coordinates and Arm Equation of four Axis SCARA Robot.

## **ELECTRICAL ENGINEERING**

**Contents for syllabi of both the Papers together for Preliminary / Stage-I Examination (Objective type Paper-II) and separately for Main/Stage-II Examination (Conventional type Paper-I and Paper-II).**

### **PAPER – II**

#### **1. Engineering Mathematics**

Matrix theory, Eigen values & Eigen vectors, system of linear equations, Numerical methods of 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, 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; ferrites, 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 and measurement accuracy, precision and standards; Bridges and potentiometers; moving coil, moving iron, dynamo meter, 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, potentiometer 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 representation 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 operations, 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, basic concepts of adjustable speed DC and AC drives, DC-DC switched mode converters, DA-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

## ELECTRONICS & TELECOMMUNICATION ENGINEERING

Contents for syllabi of both the Papers together for Preliminary / Stage-I Examination (Objective type Paper-II) and separately for Main/Stage-II Examination (Conventional type Paper-I and Paper-II).

### PAPER – I

#### 1. Basic Electronics Engineering :

Basics of semiconductors; Diode / Transistor basics and characteristics; Diodes for different uses; Junction & Field Effect Transistors Bipolar, MOS and CMOS ICs; Basics of linear ICs, operational amplifiers and their applications-linear / non-linear; Optical sources / detectors; Basics of Opto electronics and its applications.

#### 2. Basic Electrical Engineering :

DC circuits-Ohm's & Kirchoff's laws, mesh and nodal analysis, circuit theorems, Electro-magnetism, Faraday's & Lenz's laws, induced EMF and its uses; Single-phase AC circuits; Transformers, efficiency; Basics-DC machines, induction machines, and synchronous machines; Electrical power sources-basics; hydroelectric, thermal, nuclear, wind, solar; Basics for batteries and their uses.

#### 3. Materials Science :

Electrical Engineering materials; Crystal structure & defects; Ceramic materials-structures, composites, processing and uses; Insulating laminates for electronics, structures, properties and uses; Magnetic materials, basics, classification, ferrites, ferro / paramagnetic materials and components; Nano materials-basics, preparation, purification, sintering, nano particles and uses; Nano optical / magnetic / electronic materials and uses; Superconductivity, uses.

#### 4. Electronic Measurements and Instrumentation :

Principles of measurement, accuracy, precision and standards; Analog and Digital systems for measurement, measuring instruments for different applications; Static / dynamic characteristics of measurement systems, errors, statistical analysis and curve fitting; Measurement systems for non-electrical quantities; Basics of telemetry; Different types of transducers and displays; Data acquisition system basics.

#### 5. Network Theory :

Network graphs & matrices; Wye-Delta transformation: Linear constant coefficient differential equations-time domain analysis of RLC circuits; Solution of network equations using Laplace transforms-frequency domain analysis of RLC circuits; 2-port network parameters-driving point & transfer functions; State equations for networks; Steady state sinusoidal analysis.

#### 6. Analog and Digital Circuits:

Small signal equivalent circuits of diodes, BJTS and FETs; Diode circuits for different uses; Biasing & stability of BJT and JFET amplifier circuits; Analysis / design of amplifier-single/multi-stage; Feedback & uses; Active filters, timers, multiples, wave shaping, A/D-D/A converters; Boolean Algebra & uses; Logic gates, Digital IC families, Combinatorial / sequential circuits, Basics of multiplexers, counters/registers/memories/microprocessors, design & applications.

## PAPER – II

### **1. Analog and Digital Communication Systems :**

Random signals, noise, probability, theory, information theory, Analog versus digital communication & applications; Systems-AM, FM, transmitters/receivers, theory / practice / standards, SNR comparison; Digital communication basics: Sampling, quantizing, coding, PCM, DPCM, multiplexing-audio / video; Digital modulation: ASK, FSK, PSK; Multiple access: TDMA, FDMA, CDMA; Optical communication: fibre optics, theory, practice / standards.

### **2. Control Systems :**

Classification of signals and systems; Application of signal and system theory; System realization; Transforms & their applications; Signal flow graphs, Routh-Hurwitz criteria, root loci, Nyquist / Bode plots; Feedback systems-open & close loop types, stability analysis, steady state, transient and frequency response analysis; Design of control systems, compensator, elements of lead / lag compensation, PID and industrial controllers.

### **3. Computer Organization and Architecture :**

Basic architecture, CPU, I/O organisation, memory organisation, peripheral devices, trends: Hardware / Software issues: Data representation & Programming; Operating systems-basics, processes, characteristics, applications; Memory management, virtual, memory, file systems, protection & security; Data bases, different types, characteristics and design; Transactions and concurrency control, Elements of programming languages, typical examples.

### **4. Electro Magnetics :**

Elements of vector calculus, Maxwell's equations-basic concepts; Gauss', Stokes' theorems; Wave propagation through different media; Transmission Lines-different types, basics, Smith's chart, impedance matching / transformation, S-parameters, pulse excitation, uses; Wave guides-basics, rectangular types, modes, cut-off frequency, dispersion, dielectric types; Antennas - radiation pattern, monopoles/dipoles, gain, arrays-active / passive, theory, uses.

### **5. Advanced Electronics Topics :**

VLSI technology: Processing, lithography, interconnects, packaging, testing; VLSI design: Principles, MUX/ROM/PLA-based design, Moore & Mealy circuit design; Pipeline concepts & functions; Design for testability, examples; DSP: Discrete time signals/systems, uses; Digital filters:FIR / IIR types, design, speech / audio / radar signal processing uses; Microprocessors & microcontrollers, basics, interrupts, BMA, instruction sets, interfacing; Controllers & uses; Embedded systems.

### **6. Advanced Communication Topics:**

Communication networks: Principles / practices / technologies / uses / OSI model / security; Basic packet multiplexed streams / scheduling; Cellular networks, types, analysis, protocols (TCP/TCP/IP); Microwave & satellite communication: Terrestrial / space type LOS systems, block schematics link calculations, system design; communication satellites, orbits, characteristics, systems, uses; Fibre-optic communication systems, block schematics, link calculations, system design.

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