UPSC ENGINEERING SERVICE DETAILED EXAM SYLLABUS

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

(i) Stage-I: Engineering Services (Preliminary/Stage-I) Examination (Objective Type Papers) for the selection of candidates for the Stage-II: Engineering Services (Main/Stage-II) Examination;
(ii) Stage-II: Engineering Services (Main/Stage-II) Examination (Conventional Type Papers) and
(iii) Stage-III : Personality Test

2. The Engineering Services (Preliminary/Stage-I) Examination will consist of two objective type (multiple choices) questions papers and carrying a maximum of 500 marks (Paper 1 – 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-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/Stage-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 Services (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 candidate, 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.

4.2 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 examination and the preference expressed by them for the various services/posts.

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.

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

Subject	Duration	Maximum Marks
Category-I Civil Engineering		
Paper-I (General Studies and Engineering Aptitude)	2 hrs.	200
Paper-II (Civil Engineering)	3 hrs.	300
Total		500

Subject	Duration	Maximum Marks
Category-II Mechanical Engineering		
Paper-I (General Studies and Engineering Aptitude)	2 hrs.	200
Paper-II (Mechanical Engineering)	3 hrs.	300
		500

Subject	Duration	Maximum Marks
Category-III Electrical Engineering		
Paper-I (General Studies and Engineering Aptitude)	2 hrs.	200
Paper-II (Electrical Engineering)	3 hrs.	300
Total		500

Subject	Duration	Maximum Marks
Category-IV Electronics and Telecommunication Engineering		
Paper-I (General Studies and Engineering Aptitude)	2 hrs.	200
Paper-II (Electronics and Telecommunication Engineering)	3 hrs.	300
Total		500

(iii) 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
Category-I Civil Engineering		
Paper-I (Civil Engineering)	3 hrs.	300
Paper-II (Civil Engineering)	3 hrs.	300
Total		600

Subject	Duration	Maximum Marks
Category-II Mechanical Engineering		
Paper-I (Mechanical Engineering)	3 hrs.	300
Paper-II (Mechanical Engineering)	3 hrs.	300
Total		600

Subject	Duration	Maximum Marks
Category-III Electrical Engineering		
Paper-I (Electrical Engineering)	3 hrs.	300
Paper-II (Electrical Engineering)	3 hrs.	300
Total		600

Subject	Duration	Maximum Marks
Category-IV Electronics and Telecommunication Engineering		
Paper-I (Electronics and Telecommunication Engineering `)	3 hrs.	300
Paper-II (Electronics and Telecommunication Engineering)	3 hrs.	300
Total		600

(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 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 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 of 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.

Section-III
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 may 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, Aluminum, 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, concept 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 structures:**
   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 Types 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. **Environmental 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: Types of foundations & selection criteria, bearing capacity, settlement analysis, design and testing of shallow & deep foundations; Slope stability analysis, Earthen embankments, Dams and Earth retaining structures: types, analysis and design, Principles of ground modifications.

5. **Surveying and Geology:**

(a) **Surveying:** Classification of surveys, various methodologies, instruments & analysis of measurement 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 co-efficient; 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 collectors 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 Ratio, 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 – crank 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 of 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 – 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.

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 (BJTs, JFETs, MOSFETs); Transistor amplifiers of different types, oscillators and other circuits; Basics of Integrated Circuits (ICs); 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 of 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/para-

magnetic 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 & JFET amplifier circuits; Analysis/design of amplifier- single/multi-stage; Feedback& uses; Active filters, timers, multipliers, 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, compensators, 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; Waveguides-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, DMA, 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/TCPIP); 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.

Appendix-IIA

INSTRUCTIONS TO THE CANDIDATES FOR FILLING ONLINE APPLICATIONS

Candidates are required to apply online by using the website www.upsconline.nic.in.

Salient features of the system to online Applications Form are given hereunder:

1. Detailed instructions for filling up Online Applications are available on the above mentioned website.
2. Candidates will be required to complete the Online Application Form containing two stages viz. Part-I and Part-II as per the instructions available in the above mentioned site through drop down menu.
3. The candidates are required to pay a fee of **Rs. 200/- (Rupees Two Hundred Only)** [except/SC/ST candidates and those specified in Note-2 of Point 4(Fee) of the Notice who are exempted from payment of fee] either by depositing the money in any branch of SBI by cash, or by using net banking facility of State Bank of India or by using any Visa/Master/RuPay Credit/Debit Card.

4. Before start filling up Online Application, a candidate must have his photograph and signature duly scanned in the .jpg format with 200 dpi and resolution 350 pixels (Width) X 350 pixels (Height) minimum, 1000 pixels (Width) X 1000 pixels (Height) maximum in such a manner that each file should be between 20 KB to 300 KB.

5. A candidate must have his Matriculation Certificate ready prior to filling up his application form. The details viz. Candidate's Name, Father's Name, Mother's Name & Date of Birth to be filled in Online Application Form of the candidate should match exactly with particulars mentioned in the Matriculation Certificate.

6. In addition to this, candidate should also have details of one Photo ID Card viz. Aadhaar Card/Voter Card/PAN Card/Passport/Driving Licence/Any other Photo ID Card issued by the State/Central Government. The details of this Photo ID Card will have to be provided by the candidate while filling up the online application form. This Photo ID will be used for all future referencing and the candidate is advised to carry this Photo ID Card while appearing for Examination/Personality Test.

7. The Online Applications (Part I and II) can be filled from **26th September 2018 to 22nd October, 2018 till 6:00 PM.**

8. Applicants should avoid submitting multiple applications. However, if due to any unavoidable circumstances any applicant submits multiple applications then he must ensure that the applications with higher RID is complete in all respects.

9. In case of multiple applications, the applications with higher RID shall be entertained by the Commission and fee paid against one RID shall not be adjusted against any other RID.

10. The applicants must ensure that while filling their Application Form, they are providing their valid and active e-mail Ids as the Commission may use electronic mode of communication while contacting them at difference stages of examination process.

11. The applicants are advised to check their e-mails at regular intervals and ensure that the email address ending with @nic.in are directed to their inbox folder and not to the SPAM folder or any other folder.

12. **Candidates are strongly advised to apply Online well in time without waiting for the last date for submission of online application. Moreover, the Commission has introduced provision of withdrawal of application for the candidate, who does not want to appear at the Examination, he/she may withdraw his/her application.**

Appendix-IIB

IMPORTANT INSTRUCTIONS TO WITHDRAW APPLICATION

1. Candidates are advised to go through the instructions carefully before filling up the request for withdrawal of application.

2. The Commission has provided the withdrawal facility from **29.10.2018 to 05.11.2018(till 6.00 PM)** to those candidates who do not want to appear at this Examination.

3. Candidates are advised to provide the details of registered application with registration-id which was completed and submitted finally. There is no provision for withdrawing of incomplete applications.

4. Before making the request for withdrawal, candidate must ensure that they have access to the registered mobile number and email-id which were provided by them at the time of submission of application. Separate OTPs will be sent by the Commission on the registered mobile number and email-id. Request for withdrawal will be accepted only after it is confirmed by validating the OTP details sent on candidate's mobile and email-id. Such OTPs will be valid for 30 Minutes only.

5. **Request for generating OTP for withdrawal of application will be accepted only till 5.30 PM on 05.11.2018**.

6. If a candidate has submitted more than one application form then the higher registration-id of Application (latest) will be considered for withdrawal and all earlier applications will be treated as cancelled automatically.

7. After the final acceptance of the request for online withdrawal of application, the candidate must print the authenticated receipt. Once application has been withdrawn by the candidate, it cannot be revived in future.

8. UPSC has no provision to refund any fee amount paid by candidates, so in case of successful withdrawal of application the fees will not be refunded.

9. On successful completion of withdrawal of application, an auto-generated email and SMS will be sent on candidate's registered email-id and mobile. In case any candidate has not submitted the request for withdrawal of application he/she may contact UPSC on email-id: upscsoap@nic.in immediately.

10. Candidates are advised not to share the OTPs received on email and SMS to anybody.

Appendix-III

(Part – A)

Special Instruction to candidates for conventional type Papers

1. Articles permitted inside Examination Hall
   Battery-operated pocket calculators of "non-programmable" type only, mathematical/engineering/ drawing instruments, including a flat rule divided on the edges into inches and tens of an inch and into centimeters and millimeters, a slide rule, set squares, a protractor and a pair of compasses, pencils, coloured pencils, mapping pens, eraser, T-square and drawing board for use wherever necessary. Candidates are not allowed to bring with them any "Tables or Charts" for use in the Examination Hall.
2. Tables to be supplied by UPSC
   If it is considered necessary for answering the questions set in any paper, the Commission may supply any of the following for reference purpose only :

(i) Mathematical/Physical/Chemical and Engineering Tables (including Logarithmic Tables);
(ii) Steam Table (including Mollier Diagrams for Temperature up to 800• C and Pressure up to 500 Kgf/Cm);
(iii) National Building Code of India 1970 or 1983 Group 2 Part VI;
(iv) Any other special articles as may be necessary for the candidates to answer the questions set in the question paper. After conclusion of the examination, return the above items to the Invigilator.

3. Answers to be written in own hand.
   Write the answers in your own hand in ink, Pencil may be used for maps, mathematical drawings or rough work.
4. Check Answer Book.
   The candidate must write his roll number (and not his name) only in the space provided for the purpose on every answer book used by him. Before writing in the answer book, please see that it is complete. In case there are any missing pages, it should be got replaced. Do not tear out any pages from the Answer Book. If you use more than one Answer Book, indicate on the cover of first Answer Book the total number of Answer Books used. Do not leave any blank, unused spaces between answers. If such spaces are left, score them out.
5. Answers in excess of prescribed number will be ignored.
   The candidate must attempt questions strictly in accordance with the directions given on each question paper. If questions are attempted in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and the remaining answers will be ignored.
6. Questions relating to graph/precis should be attempted only on graph/precis sheets to be supplied on demand by the Invigilators. All loose sheets such as precis sheet, drawing papers, graph sheets etc. whether used or not, should be placed inside the answer books and fastened along with the additional answer book(s), if any. Candidates who fail to observe this instruction will be penalized. Do not write your roll number on these sheets.
7. Unfair means strictly prohibited.
   Do not copy from the papers of any other candidate nor allow your papers to be copied nor give nor attempt to give nor obtain nor attempt to obtain irregular assistance of any description. It will be the responsibility of every candidate to ensure that his answers are not copied by another candidate. Failure to do so will invite penalty, as may be awarded by the Commission for adoption of unfair means.
8. Conduct in Examination Hall
   Do not misbehave in any manner or create disorderly scene in the examination hall or harass or bodily harm the staff deployed for the conduct of examination. You will be severely penalized if you attempt to do so.
9. Please read carefully and abide by the instructions printed on the Question Paper and on the Answer Book supplied in the Examination Hall.
10. The candidates are not allowed to leave the Examination Hall before the expiry of prescribed time period of the examination.

(Part – B)

Special Instruction to candidates for objective type tests

1. Articles permitted inside Examination Hall.
   Clip board or hard board (on which nothing is written), a good quality black ball pen for making responses on the Answer Sheet. Answer Sheet and sheet for rough work will be supplied by the invigilator.
2. Articles not permitted inside Examination Hall
   Do not bring into the Examination Hall any article other than those specified above e.g. books, notes, loose sheets, electronic or any other type of calculators, mathematical and drawing instruments, Log Tables, stencils of maps, slide rules, Test Booklets, rough sheets pertaining to earlier session(s), etc.

The use of any mobile phone (even in switched off mode), pager or any electronic equipment or programmable device or storage media like pen drive, smart watches etc. or camera or blue tooth devices or any other equipment or related accessories either in working or switched off mode capable of being used as a communication device during the examination is strictly prohibited. Any infringement of these instructions shall entail disciplinary action including ban from future examinations. Candidates are advised in their own interest not to bring any of the banned items including mobile phones/pagers to the venue of the examination, as arrangement for safe-keeping cannot be assured.

3. **Penalty for wrong Answers (in Objective Type Papers)**

THERE WILL BE PENALTY (NEGATIVE MARKING) FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one third (0.33) 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 happens 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.

4. **Unfair means strictly prohibited**

No candidates shall copy from the papers of any other candidate nor permit his papers to be copied nor give nor attempt to give nor obtain nor attempt to obtain irregular assistance of any description.

5. **Conduct in Examination Hall**

No candidates should misbehave in any manner or create disorderly scene in the Examination Hall or harass the staff employed by the Commission for the conduct of the examination. Any such misconduct will be severely penalised.

5. Answer Sheet Particulars

(i) Write in black ball pen your Centre and subject followed by Test Booklet series (in bracket), subject code and roll number at the appropriate space provided on the Answer Sheet at the top. Also encode your booklet series (A, B, C or D as the case may be), subject code and roll number with black ball pen in the circles provided for the purpose in the Answer Sheet. The guidelines for writing the above particulars and encoding the above particulars are given in Annexure. In case the booklet series is not printed on the Test Booklet or Answer Sheet is unnumbered, please report immediately to the invigilator and get the Test Booklet/Answer Sheet replaced.

(ii) Candidates should note that any omission/mistake/discrepancy in encoding/filling of details in the OMR answer sheet, especially with regard to Roll Number and Test Booklet Series Code, will render the answer sheet liable for rejection.

(iii) Immediately after commencement of the examination please check that the Test Booklet supplied to you does not have any unprinted or torn or missing pages or items etc. If so, get it replaced by a complete Test Booklet of the same series and subject.

6. Do not write your name or anything other than the specific items of information asked for, on the Answer Sheet/Test Booklet/sheet for rough work.

8. Do not fold or mutilate or damage or put any extraneous marking in the Answer Sheet. Do not write anything on the reverse of the Answer Sheet.

9. Since the Answer Sheets will be evaluated on computerised machines, candidates should exercise due care in handling and filling up the Answer Sheets. **They should use black ball pen only to darken the circles. For writing in boxes, they should use black ball pen. Since the entries made by the candidates by darkening the circles will be taken into account while evaluating the Answer Sheet on computerised machines, they should make these entries very carefully and accurately. The candidate must mark responses in the Answer Sheet with good quality black ball pen.**

10. **Method of marking answers**

In the "OBJECTIVE TYPE" of examination, you do not write the answers. For each question (hereinafter referred to as "Item") several suggested answers (hereinafter referred to as "Responses") are given. You have to choose one response to each item. The question paper will be in the Form of TEST BOOKLET. The booklet will contain item bearing numbers 1, 2, 3 etc. Under each item, Responses marked (a), (b), (c), (d) will be given. Your task will be to choose the correct response. If you think there is more than one correct response, then choose what you consider the best response.

In any case, for each item you are to select only one response. If you select more than one response, your response will be considered wrong. In the Answer Sheet, Serial Nos. from 1 to 160 are printed. Against each numbers, there are circles marked (a), (b), (c) and (d). After you have read each item in the Test Booklet and decided which one of the given responses is correct or the best, you have to mark your response by completely blackening to indicate your response. Ink pen or pencil should not be used for blackening the circle on the Answer Sheet.

For example, if the correct answer to item 1 is (b), then the circle containing the letter (b) is to be completely blackened with black ball pen as shown below :-

Example : (a) • (c) (d)

11. **Entries in Scannable Attendance List**

Candidates are required to fill in the relevant particulars with black ball pen only against their columns in the Scannable Attendance List, as given below :-