

Scheme of Examination for the State Engineering Services (Assistant Engineer) Combined Competitive Examination

1. Scheme of Examination: - The Competitive Examination will be held in two successive stages:-
 - (i) Preliminary Examination
 - (ii) Main Examination
- (i) Preliminary Examination : the preliminary Examination will consist of two papers, i.e. one compulsory paper and one optional paper, which will be of objective type and carry a maximum of 400 marks in the subjects mentioned in Section 'A and B'. The Examination is meant to serve as a screening test only. The marks obtained in the Preliminary Examination by the candidates who are declared qualified for admission to the Main examination will not be counted for determining their final order of merit. The number of candidates to be admitted to the main Examination will be 15 times the total approximate number of vacancies (category wise) to be filled in the year in the various Services and Posts, but in the said range all those candidates who secure the same percentage of marks as may be fixed by the Commission for any lower range will be admitted to the Main Examination.

COMPULSORY PAPER	SECTION – A MAX MARKS	TIME
General knowledge & General Science including General knowledge of Rajasthan its Geography, Economy and culture	200	2 hrs

S.No.	Name of Optional Paper	Max. Marks	Time
1.	Civil Engineering	200	2 hours
2.	Electrical Engineering	200	2 hours
3.	Mechanical Engineering	200	2 hours

- (ii) Main examination: - The written examination will consist of the following papers which will be conventional type. A candidate must take all the compulsory subjects and any one of the optional subjects listed below. Each of the optional subject will have two papers. The time allowed for each paper shall be three hours.

	Compulsory Subject	Maximum Marks
Paper – I	Hindi	100
Paper – II	Social aspects of Engineering	100

	Optional Subject	Maximum Marks
Paper – III and Paper – IV	(Any one subject to opted by a candidate from the following list of optional subjects. Each subject will have two papers)	200

List of optional subjects:-

1.
 1. Civil Engineering
 2. Electrical Engineering
 3. Mechanical Engineering
2. **PERSONALITY AND VIVA-VOCE EXAMINATION:-**
 - (i) Candidates who obtain such minimum qualifying marks in the written test of the Main examination as may be fixed by the Commission in their discretion shall be summoned by them for interview. Provided that no candidate who fails to obtain a minimum of 35% marks in each of the two compulsory papers and a minimum of 40% marks in the aggregate shall be called by the Commission for interview which carries 72 marks.
 - (ii) The Commission shall award marks to each candidates interviewed by them. In interviewing the candidates besides awarding marks in respect of character, personality, address and physique, marks shall also be awarded for the candidate's knowledge of Rajasthani culture. The marks so awarded shall be added to the marks obtained in the written test or the main examination by each such candidate.
 - (iii) The standard of the papers will be that of Bachelor's Degree level except paper on Hindi which will be of Senior Secondary Level.
 - (iv) All papers unless specifically required shall be answered either in Hindi or in English, but no candidate shall be permitted to answer any one paper partly in Hindi and partly in English unless specifically allowed to do so.
 - (v) If a candidate's hand-writing is not easily legible, a deduction will be made on this account from the total marks otherwise accruing to him.
 - (vi) Credit will be given for orderly, effective and exact expression combined with due economy of words in all subjects of the examination.
 - (vii) It is obligatory for a candidate to appear in all the compulsory papers and in optional papers.

Syllabus and scope of papers

Preliminary Examination

Compulsory Paper

Paper - General Knowledge and General Science including General Knowledge of Rajasthan – its Geography, Economy and culture:

1. Current affairs: - Current events of State, National and International importance. National & International agencies and their activities. Games & Sports at State, National and International levels.
2. History & Culture: - Land Marks in the political and cultural history of India. Major monuments and literary works. Renaissance, struggle for freedom and national integration. History & Culture of Rajasthan with special reference to:-
 - (a) The medieval background.
 - (b) Socio-economic life and organisation.
 - (c) Freedom movement and political awakening.
 - (d) Political integration.
 - (e) Dialects and Literature.
 - (f) Music, Dance & theatre.
 - (g) Religious beliefs, cults, saints, poets, Warrior-saints, Lok Devtas & Lok Deviyan.
 - (h) Handicrafts.
 - (i) Fairs and Festivals, Customs, Dresses, Ornaments with special reference to Folk & tribal aspects thereof.
3. General Science: - General Science will cover General appreciation and understanding of Science including matters of everyday observations and experiences. Candidates are supposed to be familiar with matters such as electronics tele-communications, Satellites and elements of computers (both Hard & Soft Wares), research labs including CSIR managed national labs and institutes. Environment & pollution etc.
4. Economic Developments with special reference to Rajasthan: - Food and Commercial Crops of Rajasthan, Agriculture based Industries, Major irrigation and River Valley Projects, Projects for the development of the desert and waste lands. Indira Gandhi Canal Project, growth and location of industries, Industrial raw materials. Mineral based industries, Small scale and Cottage industries, export items Rajasthani handicrafts, Tribes and their economy. Cooperative movement. Tourism Development in Rajasthan. Various five years Plans: Objectives and progress. Major economic problems of Rajasthan and obstacles for economic development. Current budget of Rajasthan and Central Government. Economic Reforms in India and their impact. Commercial banks and other financial institutions in Rajasthan.
5. Geography and Natural Resources:-
 - (I) Broad – physical features of the world important places, rivers, mountains, continents, oceans.
 - (II) Ecology and wild – life of India.
 - (III) Rajasthan's Physiography: Climate, vegetation and soil regions. Broad physical divisions of Rajasthan. Human resources: problems of population, unemployment, poverty, Drought, famine and desertification in Rajasthan. Natural resources of Rajasthan. Mines and Minerals, forests, Land water. Animals' resources. Wild-life and conservation. Energy problems and conventional and non-conventional sources of Energy.

Optional Paper (Preliminary Examination)

CIVIL ENGINEERING

(Each portion to have roughly equal weightage)

A. ENGINEERING MATERIALS & CONSTRUCTION TECHNOLOGY

Selection of site for the construction of various types of buildings: Planning and orientation of buildings. Bonds in masonry. Damp proof course. Scaffolding, underpinning and ranking. Floors. Staircases. Roofs. Doors and Windows. Requirements of fire protection. Ventilation and air conditioning and acoustics. Building and highway materials and their IS codal provisions. Stones, Bricks, timber, Lime, Cement, Mortar, Plain and reinforced Cement Concrete, Bitumen, Asphalt.

B. SURVEYING

Generally adopted Scales, Chain and Compass surveying ; Leveling ; temporary and permanent adjustments of levels and Theodolite. Use of Theodolite, tacheometry, Trigonometrical and Triangulation survey. Traversing and Traverse Adjustment, Contours and contouring, Simple Circular Compound and Transition Curves and their setting out, Theory of errors and survey adjustment. Computations of areas and volumes.

C. SOIL/ GEOTECHNICAL ENGINEERING

Classification of soil as per I.S. code, Field identification tests for soils; water content, specific gravity, voids ratio, porosity, degree saturation; unit weight, density index etc; and their inter – relationship, determinations of various properties of soils as noted above as well as grain size distribution, consistency limits etc.

Soil permeability and its determination in the laboratory and field; Darcy's law, Flow nets, its Characteristics and uses.

Compaction and consolidation of soil. Quality control, soil stabilization methods. Boussinesq's methods. Newmark's chart and its uses.

Shear strength parameters and their determination Bearing capacity, local and general shear failures, design Criteria for shallow foundation, Plate load test and standard penetration test. Earth pressures on retaining wall. Stability of simple slopes. Significant depth of exploration, design features of undisturbed sampler.

D. STRUCTURAL MECHANICS

Stress and strains, elastic constants, factor of safety, relation among elastic constants. Bending moment and shear force diagrams for cantilever, simply supported and overhanging, fixed and continuous beams subjected to static loads :- concentrated, uniformly distributed and uniformly varying. Theory of simple bending. Shear Stress, Influence lines.

Deflection of cantilever, simply supported fixed and continuous beams. Determinate and Indeterminate structures and frames pin jointed, Plane and space frames.

E. STEEL STRUCTURES

Design of ordinary and plate girder beams, roof trusses welded joints, axially and eccentrically loaded columns, Grillage, Gusseted and slab base foundations. Provisions of IS : 800 and 875. Economic span of bridges.

F. REINFORCED CONCRETE STRUCTURES

Provisions of latest IS : 456, design of beams singly and doubly reinforced, design of shear reinforcement. Design of slabs spanning in two directions and T-beam slabs. Design of column axially and uniaxially eccentrically loaded. Design of isolated and combined column footings : Design of simple RCC cantilever and counterfort retaining walls. Reinforcement in overhead and underground water tanks.

G. FLUID MECHANICS INCLUDING HYDROLOGY AND IRRIGATION

Hydraulic pressure at a point and its measurement. total pressure and centre of pressure on plane and curved immersed surfaces, Buoyancy. conditions of equilibrium of floating bodies; fluid flow conditions, Bernoulli's, Navier-Stokes, Reynold's equations, flow through orifices venturimeter, notches and weirs, flow through pipes and open channels, Gradually and rapidly varied flow, Dimensional analysis, Momentum and angular momentum principles as applied to fluid in a control volume, applications of jets, Viscous flow, concept of drag, flow through pipes.

Engineering hydrology; Hydrology of floods and drought reservoirs and dams; overflow structures, ground water hydrology. Irrigation: canals, Kennedy's Lacey's theories, Khosla's theories for design of hydraulic structures. Ground water and well irrigation, water logging.

H. PUBLIC HEALTH ENGINEERING

Per capita requirement of water for urban and rural areas, Forecast of population. Sources. Water supply standards of purity of public water supplies with various methods of purification; House drainage system Distribution network with all the ancillaries: system of drainage. Layout of sewerage systems. Primary, secondary treatments, trickling filters, lagoons and other treatment units and their design criteria. Flushing of sewers; sewage treatment; rural water supply and sanitation.

I. HIGHWAY AND BRIDGES

Principles of highway planning; classification of road land width, building line, center line, formation width, terrain classification, pavement width, Camber, longitudinal gradient sight distance, horizontal curve, super elevation, vertical curve, lateral and vertical clearances.

Flexible pavements. Sub-base, base course and shoulder stone / Kankar brick soling, WBM courses, shoulders. Granular sub-base, stabilized soil roads cement / lime stabilized sub base, sand bitumen base course, crushed cement concrete base/sub-base course.

Prime and tack coats, surface dressing, open graded premix carpet, semi dense carpet, build-up spray grout base course, bituminous base binder course. Asphaltic concrete, seal coats, mixed seal surfacing. Penetration macadam base/binder course, full and semi groups.

Traffic Engineering : traffic characteristics, road user characteristics, vehicular characteristics, volume, speed and delay studies origin and destination study, traffic flow characteristics, traffic capacity and parking studies, traffic regulation, traffic control devices, Intersection control. Alignment: traffic engineering, pavement design, paving materials and highway construction and maintenance of different types of roads. Need for highway drainage and arboriculture, types of bridges: choice of type of bridge, economical considerations of fixing spans culverts.

ELECTRICAL ENGINEERING

1. Electrical Circuits: Circuit components, KCL and KVL, network graphs, Methods of circuit analysis, Nodal and Mesh analysis, Analysis of D.C. and A.C. networks. Network theorems: Basic network theorems and applications. Network Functions: Driving point and transfer functions, poles and zeros of network functions. Response of networks to standard input signals. Two-port networks, Elementary network synthesis, different type of network parameters, signal flow graphs, Fourier series, Laplace transforms and their applications. Frequency response, Resonant circuits and applications. Three-phase balanced and unbalanced networks. Steady state response with sinusoidal input. Transient response: Transient analysis of RL, RC and RLC circuits.
2. Field Theory: Electrostatic and Magnetostatics : Electrostatics and electrical fields, Magnetostatics and magnetic fields, Field in conductors and in magnetic materials, field in dielectrics, Maxwell's equations and time varying fields. Electromagnetic wave equations. Plane wave propagation in conducting and dielectric media.
3. Electrical Materials: Classification of materials on the basis of permanent magnetic dipoles, Electrical and electronic behaviour of materials, classification on the basis of conductivity. Behaviour of dielectrics in static and alternating fields. Phenomenon of polarization. Super conductivity. Applications of magnetic, conducting, dielectric and insulating materials.
4. Electrical Measurement and Instrumentation: General principles of measurement : Unit and dimensions. Standards error analysis, Basic methods of measurement, Measurement of circuit parameters by bridge methods. Measuring Instrument: Indicating Instruments, Integrating Instruments, Recording instruments. Measurement of voltage, current, power, power factor, energy, resistance, inductance, capacitance and frequency.

Transducers : strain gauge, LVDT, resistance thermometers, thermistors, piezoelectric. Measurement of non-electrical quantities (Pressure, temperature, flow rate, displacement, velocity, acceleration, strain etc.)

Digital measurements: Digital voltmeters, frequency counter, distortion meter. Telemetry and data transmission: Data recording and display, Data acquisition.

5. Electronics and Communication: Solid state (semi conductor devices) : Diodes, Zener diodes. Transistors (Bipolar, BJT, JFET, MOSFET). Biasing and their applications. Analysis of electronic circuits, equivalent circuit. Rectifier, filter and voltage regulators. Single stage and multistage amplifiers-gain and frequency response. Multivibrators, flip-flops and their applications.

Digital Electronics: Switching circuits and Boolean algebra and logic gates. Memories sample and hold circuits, A/D and D/A converters. Logic circuits including DTL, TTL, ECL, MOS, CMOS, digital IC's (circuits).

Communication: generation and detection of AM and FM noise behaviour of AM and FM systems.

6. Microprocessor systems and computer: Microprocessor architectures, Instruction set and simple assembly language programming, interfacing memory and I/O devices. Applications of microprocessors. Basic layout of digital computers, input-output devices, memory organisations, algorithms, flowcharts.
7. Power Electronics: Power semiconductor devices, Thyristor, triac, GTO, MOSFET. Static characteristics and triggering circuits. A.C. to D.C. Converters, choppers. Controlled and uncontrolled power rectifiers, Bridge converters.
8. Control System: Open and closed loop systems. Block diagrams and signal flow graphs. Response analysis time domain, frequency domain; steady state error analysis. Root locus technique, bode plots, Routh-Hurwitz, and Nyquist criteria of stability. State space analysis of linear systems.
9. Electrical Machines: Construction, Principles of operation, equivalent circuits, basic characteristics and applications of Distribution and Power transformers. Single phase induction motors. Three-phase induction motors. Alternators, Synchronous motors.
10. Power systems: Generation: thermal generation, Hydro generation, Nuclear Generation. Non-conventional energy sources. Transmission and Distribution. Transmission line parameters – resistance, Inductance and capacitance calculation, Performance of short, medium and long lines. Neutral earthing. Underground Cables. Corona, its effect and remedial measures. Basic idea of power system stability. Line insulators, introduction to HVDC transmission.

Switchgear & protection: theories of arc extinction. Comparative merits of minimum oil, bulk oil, air blast, SF₆ circuit breakers. Causes and consequences of dangerous currents. Currents limiting reactors. Busbar arrangements. Requirements of protective relays. Protection of lines, transformers, synchronous generators and busbars. Symmetrical components and their applications.

MECHANICAL ENGINEERING

1. Theory of Machines: Kinematic pairs, Kinematic chain, Mechanism and Inversion, Slider-crank chain, Displacement, velocity and acceleration of a point in mechanism and their determination, Coriolis acceleration, Mechanisms for straight line motion. Laws of friction, brakes and dynamometers, types of gears and gears trains. Types of Governors, Governor effort and power, static & dynamic balancing, Longitudinal, transverse and torsional vibration.
2. Strength of Materials: Static stresses in machine parts, Deformation, Unit deformation (Strain), Poisson's ratio, direct stress, shear stress, principal stresses. Compound stresses, torsional stress, stress – strain relationship, bending moment and shear force diagram for beams, Laminated and coil springs, shafts, thick & thin wall pressure vessels, Concept of fatigue, fracture & creep.
3. Material Science: Crystal structure, space lattice, crystalline and amorphous solids, Coordination number, Atomic packing factor, determination of crystal structure, imperfection in crystals, mechanism of plastic deformation, work hardening, recrystallization, Heat treatment of steel, Composition, Properties and applications, Common engineering materials, corrosion, Plastics & their properties.
4. Manufacturing Processes: Moulding and casting methods, Principle of arc and gas welding, Brazing & soldering, Metal forming processes, Basic machining processes and machine tools, Hot & cold working of metals, Mechanism of metal cutting, geometry of single point cutting tool and tool materials.
5. Industrial Engineering and Management : Types of business organization, Principles of management, elements of management, organization charts, elements of costing, Break even analysis, types of budget and budgetary control, Profit & Loss account, balance sheet, motion study, time study, plant layout, material handling, CPM, PERT, Scheduling, dispatching, routing and inventory, Materials management.
6. Thermodynamics: Basic concepts of thermodynamics, Laws of thermodynamics and their application to different flow and non-flow systems, Gas power cycles and vapour power cycles.
7. Heat transfer : Conduction, convection and radiation phenomenon, Combined modes of heat transfer, Critical insulation, Fins, Non-dimensional numbers applied to heat transfer, Thermal boundary layer, Introduction to two phase heat transfer, Heat exchangers.
8. Environmental Engineering : Basic air and refrigeration cycles, Vapour compression refrigeration, Vapour absorption refrigeration, Expansion devices, Refrigerants and their properties, Psychrometric chart and psychrometric processes, Air conditioning for human comfort and comfort chart, Cooling load calculation.
9. Fluid Mechanics and turbomachines : Fluids and their properties, Kinematics and dynamics of fluid flow, dimensional analysis and similitude, Introduction to boundary layer flow, fluid flow through pipes, Flow measurements, Hydraulic pumps and turbines, Air compressors, Gas turbines and steam turbines.
10. Power Generation : SI and CI engines, Combustion phenomenon, Fuels, carburetor and injection system, High pressure modern boilers, Steam plant layout and different accessories, Hydro power plant layout, Introduction to nuclear, MHD and biogas power plants, Economics and sharing of load techniques of different plants.

Main Examination Compulsory Subject

अनिवार्य विषय— हिन्दी

अनिवार्य प्रश्न पत्र : 01

अवधि : 3 घंटे

अधिकतम अंक : 100

अनुभाग — अ : 30 अंक
अनुभाग — ब : 50 अंक
अनुभाग — स : 20 अंक

अनुभाग — अ		30 अंक
1. संधि :	दिये हुए शब्दों में संधि करना और संधि-विच्छेद करना :	02 अंक
2. समास :	दिये हुए शब्दों से सामासिक-शब्दों की रचना करना और समास-विग्रह करना	02 अंक
3. उपसर्ग :	उपसर्गों को सामान्य ज्ञान, उनके संयोग से शब्दों की संरचना और शब्दों में विद्यमान उपसर्गों को अलग करना	02 अंक
4. प्रत्यय :	प्रत्ययों का सामान्य ज्ञान, उनके संयोग से शब्दों की संरचना और शब्दों में विद्यमान प्रत्ययों को अलग करना	02 अंक
5. पर्यायवाची तथा विलोम शब्द		02 अंक
6. शब्द युग्मों का अर्थ भेद		02 अंक
7. वाक्यांश के लिए एक सार्थक शब्द		02 अंक
8. शब्द शुद्धि :	दिये हुए अशुद्ध शब्दों को शुद्ध रूप में लिखना	
9. वाक्य शुद्धि :	दिये हुए विभिन्न व्याकरणिक अशुद्धियों वाले वाक्यों को शुद्ध रूप में लिखना	02 अंक
10. मुहावरे :	दिये हुए मुहावरों का वाक्यों में प्रयोग द्वारा अर्थ स्पष्ट करना	04 अंक
11. लोकोक्तियाँ :	दी हुई लोकोक्तियों का वाक्यों में प्रयोग द्वारा अर्थ स्पष्ट करना	04 अंक
12. पारिभाषिक शब्दावली :	तकनीकी अंग्रेजी शब्दों के समानार्थक हिन्दी शब्द	04 अंक

अनुभाग — ब		50 अंक
1. संक्षिप्तीकरण :	दिये हुए गद्य-अवतरण का एक तिहाई शब्दों में संक्षिप्तीकरण, उसका उचित शीर्षक तथा अवतरण से संबंधित प्रश्नों के उत्तर	10 अंक
2. वृद्धीकरण :	किसी सूक्ति, प्रसिद्ध कथन आदि का भाव-विस्तार	10 अंक
3. पत्र लेखन :	व्यावसायिक एवं कार्यालय संबंधी पत्र	10 अंक
4. प्रारूप लेखन :	निविदा, अधिसूचना, परिपत्र, ज्ञापन, विज्ञप्ति आदि के प्रारूप की सामान्य जानकारी	10 अंक
5. अनुवाद :	दिये हुए अंग्रेजी अवतरण का हिन्दी अनुवाद	10 अंक

अनुभाग — स		20 अंक
1. निबन्ध लेखन :	किसी सम-सामयिक अथवा सामान्य विषय पर निबन्ध (शब्द सीमा : 500 शब्द)	20 अंक

Compulsory Paper(02) - SOCIAL ASPECTS OF ENGINEERING

Maximum Marks: 100

1. Development Processes: Inter relationship between social, economic, scientific and technological factors for development. Development criteria; gross national product, energy consumption, quality of life.
Role of planning. Five year plans.
2. Development of Science and Technology: Industrial revolution in Europe. Science and Technology development in India before independence. Scientific policy resolution of 1958, Technology policy statement of 1983, Technology missions, Information technology.
3. Technology for rural and Desert Areas: Characteristic of desert areas, Thar desert , desertification and its control, sand dunes stabilisation.
Rural economy, poverty, unemployment, exodus to urban areas.
Rural energy needs, Deforestation, Improved chalas, Biogas plants, Solar appliances, rural industries.
Soil and water conservation, water harvesting, watershed planning. Thermal comfort aspects of housing, transport in rural and desert areas. Drought, Famine and Disaster management.
4. Technology Assessment and Transfer: Criteria for assessment and selection of technology, appropriate technology concept, technology transfer and development.
5. Human Relations in Industry and Industrial Laws: Application of social sciences to industry, leadership and supervision, Labour relations, Trade unions, Salient features of Factory Act, Workmen's Compensation Act, Minimum Wages Act.
6. Project Planning, Appraisal and Feasibility: Techno economic feasibility studies, Project planning and control, Use of CPM and PERT, Fixed and variable cost, Cost-benefit ratio, Break even analysis, Depreciation, life cycle costing.
7. Globalisation of Economy: World Trade Organization (W.T.O.), trade related Intellectual Property Rights (TRIPS), Quality assurance, ISO 9000 certification. Optimisation of human, capital and material resources.

8. Environmental Degradation and Resource Depletion : Environmental degradation due to energy production, transport, industries, mining and intensive agricultural practices, control of air and water pollution. Hazards of environmental pollution.

Depletion of natural resources due to population explosion and continuously rising standards of living. Environment impact analysis of projects, green technologies, Concept of sustainable development. National environmental laws.

OPTIONAL SUBJECT (MAIN EXAM.)

Subject- CIVIL ENGINEERING - I

(Each portion to have roughly equal weightage)

Maximum Marks: 200

- A. **STRENGTH OF MATERIALS:** Behaviour of engineering materials in tension, compression and shear, elastic limit, yield stress, proof stress, nominal stress, actual stress and ultimate stress, factor of safety, load factor and elastic constants.
Principal stresses and strains, Strain energy, theories of elastic failure.
Bending moment and shear force in statically determinate beams, stress due to bending moment and shear force, design of section, section modulus, elementary theory of torsion, combined bending and torsion. Forces in statically determinate plane trusses.
Slope and deflection of statically determinate beams, deflection of statically determinate frames – Buckling of columns. Euler's, Rankine's and secant formulae. Combined, direct and bending stresses for short columns. Thin cylindrical and spherical shells.
- B. **SOIL AND FOUNDATION ENGINEERING:** Soil Exploration: Methods of site exploration, boring, sampling, standard penetration test.
Preliminary definitions and relationship: Water content unit weight, specific gravity, void ratio, porosity and degree of saturation, density index, phase relationship.
Index Properties: Specific gravity, particle size distribution, consistency of soils. Classifications of soils, field identification.
Laboratory Test: Particle size analysis, liquid limit, plastic limit, proctor density, field density, permeability, shear box and unconfined.
Soil water: Inter-granular and pore water pressure, Quick sand phenomenon, permeability, Flow not and its uses.
Vertical pressure distribution: Boussinesq's equations, Circular load, pressure bulb and its significance, Newmark's chart. Contact pressure distribution.
Consolidation: Concept of one-dimensional consolidation. Laboratory consolidation test, over-consolidated normally consolidated soils, settlement analysis.
Shear Strength: Basic concept, Mohr-Coulomb Failure theory and measurement of shear strength.
Earth Pressure: Lateral earth pressures (Active and Passive), Rankine's and Coulomb's theory.
Stability of slopes: Methods of slices, friction circle method, Taylor's method.
Bearing Capacity: Definitions, Terzaghi's method, general shear and local shear failures, plate load test.
Compaction: Field Compaction method, water content, field compaction control and factors affecting compaction. Pile Foundation: Types of piles, driving of piles, load carrying capacity of piles, pile load testing, under-reamed pile foundation, bored compaction piles.
Well Foundations: Caissons, shapes of wells and component parts depth of well foundation and bearing capacity, forces acting on a well foundation. Well sinking.
- C. **THEORY OF STRUCTURES:** Statically Indeterminate Structures : Static and kinematics indeterminacy, Energy theorems, Stiffness and flexibility methods elementary analysis of structures, methods of consistent deformation, slope deflection and moment distribution. Analysis of beams (including continuous) and portal frames, Influence lines, Influence lines for moment, shear and reaction for statically determinate beams and planar trusses. Muller-Breslau Principle and influence lines for indeterminate beams. Rolling loads on beams- shear force and bending moment due to concentrated loads, uniformly distributed loads- shorter and longer than span.
- D. **STRUCTURAL DESIGN-I:** Loads: Specifications for loads on buildings and bridges.
Reinforced concrete: Limit state theory, resistance to bending, shear and bond. Design of singly and doubly reinforced beams, one way, two way and flat slabs, columns with axial; and uniaxial moment loading, footing, cantilever and counterfort retaining walls, simple underground and elevated reservoirs, cantilever sheds, simple rectangular portal frames, spherical domes, staircase.
Pre-stressed Concrete: Properties of high grade concrete and high tensile steel, pre-tensioning and post tensioning losses in pre-stress. Analysis and design of rectangular beams and slab.
- E. **STRUCTURAL DESIGN-II:** Steel Structures : Tension and compression members, single and built up sections, connection and splices, roof trusses, simple beams and Purlin connections, columns, lacing and batten, Grillage, Gusseted and slab base foundation. Plate and gantry girders, through and deck type plate girder bridges and with lateral bracings.

Subject- CIVIL ENGINEERING - II
(Each portion to have roughly equal weightage)

Maximum Marks: 200

- A. **FLUID MECHANICS:** Fluid properties, types of flow, Fluid statics, forces on fully and partially submerged bodies, stability of floating bodies. Fluid kinematics, acceleration of fluid particle, velocity potential and stream function, irrotational flows, ideal fluid flow, Bernoulli's, Navier Stokes, Reynold's equations, application. Flow measuring devices.
Momentum and angular momentum principles as applied to fluid in a control volume, applications to jets. Introduction of viscous flow, concept of drag. Flow through pipes, Laminar and turbulent. Equations for boundary layer thickness and boundary shear over flat plates. Channel Flows (GVF and RVF), surges. Dimensional analysis and similitude techniques.
- B. **SURVEYING:** Distance Measurements: Use of steel and metallic tapes, application of corrections, measurement of base line, errors in base line measurements, reduction to mean sea level, specifications for base line measurements, optical measurements of distances, use of substance bars.
Angle Measurements: Principles of theodolite constructions, temporary and permanent adjustment, precision in relation to nature of work, compass, varieties, limitations. Traverse adjustments.
Verticle Measurements : Use of leveling instruments of level, level tubes, estimation of sensitivity, optics, care and maintenance, parameters to define quality of telescope, leveling instruments and theodolities, methods of records and reducing, stadia reductions, use of level rods, contouring, drainage and watershed lines.
Methods of filling in details: Chain and compass, plane table and traverse surveys. Principles and adjustments of closed traverse, determination of missing data, solution of two point and three point problems.
Other Surveys: Curve ranging using linear and angular measurements, simple compound and spiral curves.
Measurements of area and volumes: Use of planimeter, measurements of areas and volumes including prismoidal, trapezoidal and Simpson's method.
- C. **CONSTRUCTION MATERIALS:**
(i) Building Materials : building stones, building bricks, steel (Plain, Tor, High-tensile and Structural), Timber, lime, cement, sand, surkhi, cinder, stone slabs and lintels, aggregates for cement concrete, paints, distempers, use of pozzolana manufacturing of lime concrete, cement concrete for plain, reinforced and pre-stressed concrete work.
(ii) Road Materials: Coarse aggregate, screenings and binding materials for WBM. Bricks for soling. coarse and fine aggregate for bituminous roads, IRC standard size aggregates, Tars and Asphalt. Asphaltic concrete, Asphaltic emulsions, Mastic Asphalt and Minerals fillers.
(iii) Constructions Stone Masonry: Ashlar, course rubble, random rubble, stone pillar, dry stone and arch masonry.
Bricks Masonry: Types and their uses hollow and reinforced brick work.
Wood work: doors and windows.
Steel works: Structural steel work, metal doors and windows.
Roofing: Stone slab roofing, G.C. Steel sheet roofing, Asbestos cement sheet roofing, jack arch roofing, tile and thatch roofing.
Flooring: Cement concrete flooring, flag stone flooring, terrazzo mosaic flooring, Terrazzo file flooring, Brick on edge flooring, timber Granolithic floor finish, linoleum and other floorings.
Plastering: Lime plaster, cement sand plaster, composite, plaster, rough coat plaster, Araish plastering with Gypsum, Plaster of Paris, painting.
Miscellaneous: Damp proof course, anti-termite treatment, sill, coping and corbelling.
Centering and Shuttering: Centering form work, shuttering and moulds, timber trestles and false work, scaffolding and shoring, under pinning.
Sanitary and Water Supply : Providing and laying galvanized iron PVC, asbestos cement, stone ware, cast iron and RCC pipes; sewerage and drainage system; over head and under ground tanks; manholes and gully chambers ; septic tank; soak pit, dispersion trench, floor and wall treatment in toilets, glazed tile work, downpour pipes.
Construction Management: Management of construction, plants and equipments. Planning for construction using network analysis C.P.M. and PERT techniques.
Shallow foundation: spread foundation, combined footing and strap footing, Mat or Raft Footing.
- D. **HYDROLOGY AND WATER RESOURCES ENGINEERING:** Engineering Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration and infiltration. Estimation of dependable runoff factors effecting runoff. Rainfall runoff relationship, flood/drought estimation using frequency analysis and unit hydrograph methods. Groundwater hydrology, aquifers, steady flow towards fully penetrating wells confined and unconfined aquifers.
Crop water requirements: consumptive use of water. Water depth and frequency of irrigation. Soil moisture and its variation in the root zone. Wilting point. Field capacity. Different methods of irrigation and irrigation efficiency. Duty, delta and outlet factor. Cropping patterns. Intensity of irrigation, Command area development and its related problems.
Diversion Head Works: Principles of design of weirs on non-permeable and permeable foundations. Khosla's theory, designs for uplift and exit gradient. Silt exclusion from canal head works.

Canals: Lined and unlined canals. Lacey's and Kennedy's theories, Tractive force approach. Types of lining and its selection criteria.

Lift Irrigation from Canals and Wells

Ground water availability in unconfined aquifers. Safe yield formulae, construction and maintenance of wells. Relative merits of lift irrigation and flow irrigation.

Storage Works: Different types of dams. Elementary concepts of masonry, concrete, earthen, buttress and arch dams. Forces gravity dams. Structural behaviour stability considerations and stress variation in gravity dams. Appurtenances, Foundation Treatment and control of seepage.

Multi-purpose Project : Compatibility of Multi-purpose uses. Data needed in planning of multi-purpose water resources projects. Reservoir planning, Environmental consequences of irrigation. Water logging, problems of alkalinity and salinity, Farm drainage and CAD works.

- E. **TRANSPORT AND TRAFFIC ENGINEERING:** Survey investigation and preparation of road project. Highway standard classification, land width, building line center line, formation width, terrain classification, pavement width Camber longitudinal gradients, sight distance horizontal curve, super elevation, vertical curve, lateral and vertical clearances.
Design of Pavement: Flexible pavements.

Pavement Construction: Sub-base, base course and shoulder stone/kankar brick soling, WBM courses, shoulders. Granular sub-base, stabilized soil roads, cement/lime stabilized sub-base, sand bitumen base course, crushed cement concrete base/sub-base course.

Bituminous Course: Prime and tack coats, surface dressing, open graded premix carpet, semi dense carpet, built-up spray grout base course, bituminous base binder course. Asphaltic concrete seal coats, mixed seal surfacing. Penetration macadam base/binder course, full and semi grouts.

Traffic Engineering : Traffic characteristics, road user characteristics, vehicular characteristics, volume, speed and delay studies origin and destination study, traffic flow characteristics, traffic capacity and parking studies, traffic regulation, traffic control devices, Intersection control. System approach in traffic management.

Bridge Engineering: Components of bridges, classification of bridges, requirements of an ideal bridge, selection of bridge site, Bridge alignment, site investigation and collection of data, waterway of bridges. Economic span scour depth of foundation, Afflux, clearance, free board. Type of bridge superstructures and methods of erection, bridge bearings, joints in bridge, wearing coat, Railing, parapet and approach slab.

Type of bridge foundation, bridge pier, adjustment and wing walls. Training work for bridges and protection works. Low cost bridges, causeway, timber bridges, suspension bridges, pipe and slab culverts.

- F. **WATER SUPPLY AND SANITARY ENGINEERING:** Water Supply Engineering: Quantitative requirements of water supply for urban and rural areas. Variation in demand. Forecast of population. Different sources of water supply, lakes, rivers and ground water. Intake arrangements. Drinking water standard for water. Bacteriological test. Pumping of raw water. Design of rising mains. Water treatment, flow diagram, sedimentation coagulation, filtration and disinfection, water softening and aeration of water. Water distribution system and their design and analysis. Clear water reservoirs. Rural water supply and sanitation. Problems of low cost potable water for rural population. Tube wells for water supply. Safe yield from tube wells.

Sanitary Engineering: sewerage, separate sewers and combined sewers. Hydraulic and structural design considerations. Different types of pipe material and different shapes of build up sewers. Superimposed load on sewers. House plumbing, various accessories and arrangement. Sewage pumping station.

Characterization of Sewage : Physical, chemical and biological analysis, Industrial waste water and its problems, natural purification process through soil mass and through water bodies self purification of streams. Sewage treatment, Physical treatment, screening, skimming tanks, Grit chamber, Settling tanks. Secondary (biological) treatment, trickling filters and high rate bio filters. Activated sludge and accelerated aeration plants. Secondary, settling tanks, sludge digesters and sludge drying. Final disposal, Low cost waste water treatment oxidation ponds, oxidation ditches, aerated lagoons, septic tank, anaerobic lagoons. Dry refuse disposal. Basic concepts of Urban and Rural sanitation.

Subject- ELECTRICAL ENGINEERING - I

Maximum Marks: 200

1. Electrical Circuits: Circuit elements, Kirchhoff's laws, Mesh and nodal analysis, topological concepts, Network Theorems and applications. Natural response and forced response. Steady state and transient response for standard inputs. Properties of network in terms of poles and zeros. Transfer functions. Resonant circuits. Three-phase balanced and unbalanced circuits. Two port networks. Signal flow graphs. Coupled circuits. Filters, image impedance, attenuation, phase shift and insertion losses in constant K and M derived filters. Fourier series, Laplace transforms and their application.
(40)
2. Field Theory: Electric and magnetic fields, Gauss's law, Ampere's law, Divergence and curl. Fields in dielectrics, conductors and magnetic materials, Maxwell's equations. Time varying fields. Wave propagation in dielectric and conducting media. (30)
3. Electrical Materials: Classification of materials on the basis of permanent magnetic dipoles. Electrical and electronic behaviour of materials. Classification on the basis of conductivity. Behaviour of dielectrics in steady and alternating fields. Phenomenon of polarization. Super conductivity. Application of magnetic, conducting, dielectric and insulating materials, Piezoelectricity. (30)
4. Electrical Machines: Construction of large power and distribution transformers, Phasor diagram and equivalent circuit of transformers. Regulation and testing of transformers, power loss calculations, efficiency and all day efficiency.
Starting methods of single phase motors. Applications in domestic appliances. Principle of operation, constructional features and performance analysis of three-phase induction motors. Torque-slip characteristics, Circle diagram. Methods of starting and testing.

Construction, circuit model, operating characteristic, performance analysis, synchronous reactance, efficiency, voltage regulation, parallel operation of an alternator.

Starting of synchronous motor, V-curves, hunting and its prevention. (50)
5. Power systems: Type of power stations : hydro, thermal and nuclear stations. Pumped storage plants. Economics and Operating factors.
Power transmission lines, modelling and performance characteristics, voltage control, optimal power system operation. Load frequency control, symmetrical short-circuit analysis. Symmetrical components, p.u. representation, fault analysis, transient and steady state stability of power systems. Equal area criterion. Corona, Neutral earthing. Power system transients, power system protection, circuit breakers, relays, H.V.D.C. transmission. (50)

Subject- ELECTRICAL ENGINEERING - II

Maximum Marks: 200

1. Electrical Measurement and Instrumentation: Units and standards. Error analysis. Measurement of current, voltage, power factor and energy, Indicating instruments. Measurement of resistance, inductance, capacitance and frequency by bridge methods, electronic measuring instruments, digital voltmeter and frequency counter.
Transducers and their applications for the measurement for non-electrical quantities like temperature, pressure, flow rate, displacement, velocity, acceleration. Telemetry and data transmission. Data acquisition systems. A/D and D/A converters. (40)
2. Electronics and Communication: Semiconductor devices physics. P-N junction and transistors, circuit models and parameters. FET, ZENER, TUNNEL, SCHOTKY, photodiodes and their applications, rectifier circuits, voltage regulation, switching behaviour of diodes and transistors, small signal amplifiers biasing circuits, frequency response, multistage amplifier and feedback amplifiers. D.C. amplifiers, oscillators.
Large signal amplifiers: coupling methods, push-pull amplifiers, operational amplifier, wave shaping circuits,. Multivibrators, flip-flop and their applications. Digital logic gate families, universal gates, combinational circuit for arithmetic and logic operation, sequential logic circuits. Counters, registers, RAM and ROMs.

Communication: Generation and detection of AM and FM, noise behaviour of AM and FM systems. (40)
3. Power Electronics : Power semiconductor devices. Thyristor, power transistor, GTOs and MOSFETs characteristic and operation A.C. to D.C. converters, single-phase and three-phase D.C. to D.C. choppers. Inverters, single-phase and three-phase pulse width modulation. Sinusoidal modulation. Switched mode power supplies. (40)
4. Microprocessor systems and computers: Microprocessor architecture, instruction set and simple assembly language programming. Interfacing memory and I/O devices. Applications of microprocessors. Basic layout of digital computers, input-output devices, memory organizations. Algorithms. Flow charts. (40)
5. Control System: Open and closed loop systems. Block diagrams and signal flow graphs, transfer function. Response analysis, time domain, frequency domain, steady-state error analysis. Root locus technique, Bode plot, Routh-Hurwitz and Nyquist Criteria of stability. State space analysis of linear systems. (40)

Subject- MECHANICAL ENGINEERING - I

Maximum Marks: 200

- Theory of Machines:** Kinematics and dynamic analysis of mechanisms, Coriolis component of acceleration, Mechanisms for straight line, Motor vehicle steering mechanism, Hooke's Joint and Geneva mechanism, Kinematics synthesis of mechanism, Velocity and acceleration analysis, Brakes and dynamometers, Cams, Governors, Gears and Gear trains, fly wheel and turning moment diagram, Friction (types), Laws of friction, Inclined plane, Ball & roller bearings, single and multiplate clutches, Force analysis of machines, Force and inertia torque analysis of mechanisms, Balancing of rotating and reciprocating masses, Balancing of single and multicylinder engines, Gyroscopic motion, vibration analysis of free, damped and forced vibration of single degree of freedom, Vibration isolation and transmissibility, Transverse vibration and whirling (critical) speed of shaft, torsional vibration up to three rotor system, geared system, Holzer's method.
- Materials Science:** Crystal structure, space lattice, crystal systems, Miller indices, Imperfection in crystal, determination of crystal structure, mechanism of plastic deformation, Theory of work hardening and recrystallization, concept of creep, fatigue and fracture, Phase diagrams, Heat treatment of steels, Plain carbon steel, alloy steels, effect of alloying elements in steel, Composition, application and properties of common engineering materials, Materials for Nuclear energy and bearing materials.
- Machine Design:** Design procedure and flow diagram, Factor of safety, unit deformation (strain), Types of stresses, stress-strain relationship, Deflection in beams, bending moment & shear force diagram, Eccentric loading, theory of fatigue, Statistical nature of fatigue, Endurance limit and its modification factor, Concept of fracture in ductile and brittle metals, Creep behavior in metals, Design of levers, beams, shafts, laminated and helical springs, belt, pulleys and flywheel, power screw, gear drives and friction clutches, thin and thick wall pressure vessels.
- Manufacturing Processes:** Types of patterns and pattern making, Moulding and casting methods, Principles of arc welding and equipment, oxy-acetylene gas welding, gas welding flames, Brazing and Soldering, hot and cold working of metals, Introduction to Lathe, Milling, shaper and drilling machine, Cutting tools, Merchant's force analysis, geometry of single point cutting tool, types of chips, Taylor's tool life equation, Economics of metal cutting, Modern machining methods, NC & CNC, Jigs & fixtures, fits, tolerances and limits, measurements of screw threads and gear profile, gear manufacturing, Press tools and high velocity forming.
- Industrial Engineering:** Type of business, their formation and dissolution, Government control, public corporations and co-operative societies. Introduction to management, Principle of Management, elements of management, contribution of Taylor, Gilbreth, Fayol and Mayo in the development of management, Forms of organization, management structure, Authorities and responsibilities, organizational charts, span of control, Work study and productivity, motion study, time study, theory of work sampling, Make and buy decision, probability theory, Game theory, replacement theory, principle of plant layout, Material handling: functions, engineering & economic factors, production planning and control, routing, scheduling and dispatching, Gantt's chart, CPM, PERT, Material Management, Planning and Programming, Inventories, lot size, lead time, re-order point, wages payment system, Introduction to linear programming, Value engineering, JIT and MRP, Labour legislation, Industrial Relations.

Subject- MECHANICAL ENGINEERING - II

Maximum Marks: 200

- THERMODYNAMICS:** Basic concepts of thermodynamics, Properties of pure substances, First law of thermodynamics applied to closed and open systems, Second law of thermodynamics, Carnot cycle, entropy, Second law analysis of engineering systems, Availability.
Gas Power Cycles: Air Standard Efficiency, Otto cycle, Diesel cycle, Brayton cycle with modifications, Ideal jet propulsion cycle.
Vapour Power Cycles: Carnot and Rankine cycles, reheat and regenerative cycles, reheat factor, binary vapour cycle, combined gas-vapour power cycle.
Combustion: Solid, liquid and gaseous fuels, stoichiometric air and excess air, Gas analysis, Different calorific values, Enthalpy of reaction and enthalpy of formation, Dissociation.
- HEAT TRANSFER:**
Conduction: One- dimensional steady state heat conduction, Heat conduction through composite walls, Critical thickness of insulation, Heat transfer from finned surfaces, fin efficiency and effectiveness.
Convection: Free and forced convection, Dimensional analysis, Heat transfer correlations, Hydrodynamic and thermal boundary layers, boundary layer equations and their solutions for flat plates and pipes.
Radiation: Planck's distribution law, Radiation properties, Kirchoff's law, diffuse radiation, Lambert's law, Intensity of radiation, Heat exchange between two black surfaces, Heat exchange between gray surfaces, radiation shield, Electrical analogy,
Boiling and Condensation: different regimes of boiling heat transfer, Correlations of boiling heat transfer, Heat transfer coefficient for laminar film condensation on flat plate, Drop wise condensation.
Heat Exchangers: Different types of heat exchangers, Logarithmic mean temperature difference and effectiveness for parallel flow and counter flow heat exchangers, Correction factor and fouling factor, Heat exchanger design by LMTD and effectiveness NTU methods.
- FLUID MECHANICS AND FLUID MACHINES :**

Fluid Mechanics: Fluids and their properties, buoyancy and floatation, Kinematics and dynamics of fluid flow, similitude and dimensional analysis, Incompressible fluid flow in pipes, Steady flow of compressible fluids – normal shock waves, Fanno and Rayleigh lines, Oblique shock waves, Flow in a pipe with friction, Flow of viscous fluids – laminar and turbulent boundary layers, Fluid flow measurement.

Fluid Machines: Centrifugal pumps: constructional details, specific speed, manometric and overall efficiencies, characteristic curves. Hydraulic turbines: classification constructional features of Pelton, Francis and Kaplan turbines, specific speed, velocity triangles, efficiencies, characteristic curves, governing systems, draft tubes, cavitation.

4. ENVIRONMENTAL ENGINEERING :

Refrigeration : Basic refrigeration and heat pump cycles, Air refrigeration system, Aircraft refrigeration, Vapour compression refrigeration, Vapour absorption system, Refrigerants, Refrigerator components and controls, Unconventional methods of Refrigeration.

Air-conditioning: Psychrometric charts, Different air-conditioning processes, Air-conditioning systems and equipments, air-conditioning plants, Selection of air-conditioner, Layout of different air-conditioning systems, Air-distribution, duct design, Cooling Loads and their calculations, Human comfort and comfort chart, Different applications of refrigeration and air-conditioning.

5. ENERGY CONVERSION :

Combustion Internal Engines: S.I. and C.I. engines, Combustion phenomenon, Combustion chambers, carburetion and fuel injection, Supercharging, engine fuels, various efficiencies and performance of I.C. engines, Engines emission and control.

Steam Turbines: Flow of steam through nozzles, Steam turbine types, Velocity diagrams for impulse and reaction turbines, Efficiencies and governing.

Gas Turbines: Centrifugal and axial flow compressors, Energy transfer equation, Velocity diagrams, Efficiency and performance of gas turbines, Multistage compression, Reheat and regeneration.

6. POWER PLANT ENGINEERING :

Steam Power Plants: High pressure steam boilers and accessories, plant layout, Fuel handling and firing, ash, smoke and dust removal, Fluidized bed, Chimney and draught, Condensers, Heat balance sheet, Plant operation and maintenance, Thermal pollution and control.

Hydro-electric power plants: Selection of site, Different layouts, Efficiency and load curves, Hydrology, hydrological cycle and hydrograph, Control in hydro-electric plants, Economic loading of hydro-power plants.

Nuclear power plants: Nuclear reactions and fuels, Nuclear reactors, Nuclear power plant economics, Safety measures & site selection, Comparison of Nuclear, steam and hydro plants.

Power plant economics: Economic load sharing between base load and peak load plants, typical load curves, Effect of variable load on power plant.