

## 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.

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

SECTION – B			
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
4.	Agricultural 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
  4. Agricultural 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 wires, 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, pavem 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. Threephase 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, SF<sub>6</sub> 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 gear 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.

## Agricultural Engineering

1. **Surveying, Leveling and Land Development :-** Linear Measurements, different surveying devices and methods, land grading and leveling, contouring and terracing, earth work estimation, land development budgeting.
2. **Soil and Water Conservation:** - Precipitation, hydrologic cycle, point rainfall analysis, frequency analysis. Watershed : definition and concept, agricultural watersheds, prediction of peak runoff, factors affecting runoff, hydrograph, concepts of unit and instantaneous hydrographs. Erosion-type and factors associated with erosion, assessment of actual annual soil loss by erosion and its impact on agricultural production and productivity. Erosion control measures on various classes of lands i.e. contour cultivation, strip cropping, terracing, afforestation, pastures etc. Role of vegetation in soil and water conservation, grassed water way and design. Design of gully control measures including permanent structures i.e. chute spillway, drop spillway, drop inlet spillway, retards and stream bank erosion mechanics of wind and water erosion, wind erosion control, water harvesting structures i.e. Khadin, Tanka, Nadi and Anicut.
3. **Irrigation –** Soil-Water- Plant relationship, water requirements of different crops and irrigation scheduling, direct and indirect methods of soil moisture measurements, measurements of irrigation water. Water conveyance and control, design of field channels. Design of irrigation methods, irrigation efficiencies. Drainage : Benefits of drainage, Surface drainage, drainage of flat and slopping lands. Design and layout of surface and sub surface drains, depth and spacing of drains and drainage outlets, installation of drains and drainage wells. Pumps :- Construction and performance

characteristics, selection, installation, working principle and maintenance of reciprocating pump, centrifugal pump, turbine pump, submersible Pump, propellers, jet and air lift pumps. Water Resources Development and Management: Water resources of India, surface water, ground water, development of irrigation potential, canal irrigation, command area development, on farm development works, aquifer parameters, hydraulics of wells, steady and unsteady flow, well log, construction of wells, well development.

4. **Farm Power and Machinery** – Classification of Internal combustion (IC) engines terminology, Otto diesel cycle, engine components, Fuel supply system, Lubrication system, Cooling system and Governing system, steering system, hydraulic system. Types of tractors, brakes, power transmission system. Traction theory and mechanics of tractor chassis and selection of tractors. Farm Machinery : Tillage, primary and secondary tillage equipment, Selection of sowing and planting equipment and their calibration, Selection and calibration of sprayers and dusters. Principles, selection and operation of harvesting and threshing machinery. Cost analysis of farm equipment and related numerical problems.
  5. **Agricultural Processing** : Various size reduction machinery and material handling equipment. Separation equipment-based on size shape and surface characteristics. Heating and Cooling of food products, mode of heat transfer and types of heat exchangers. Psychometric chart and its application in drying EMC and its determination, Principles of drying and drying equipments, types of evaporators, Refrigeration load calculation, various milling process for Rice, Maize, Wheat and Pulse milling, Parboiling of wheat and paddy. Grains storage structures and their design requirement. Principles of food preservation and thermal processing.
  6. **Farm electrification and rural hosing** :- Selection, Installation and general cares of electric motors on farms, selection of wire sizes based on Indian standards. Types of wiring, rural electrification programme. Rural Housing :- Building materials and their properties, Design of Beams, Slabs, Columns and foundations, Planning and design of rural houses, farm Roads, village drainage system, waste disposal and sanitary structures, material and cost estimation in construction.
  7. **Renewable Energy** : Solar Radiation – its measurement, solar thermal devices and gadgets i.e. solar cooker, solar water heater, solar dryer, solar refrigeration and air conditioner etc. Solar photovoltaic devices, Bio energy – production, conversion and utilization route, Biogas – type of biogas plant and design of Biogas Plant. Biomass gasification and gasifier wind energy conversion process i.e., water pumping, wind mills and aero generator.
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