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

Main Examination

Compulsory Subject

अंकितम 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 :

2. समास : दिये हुए शब्दों से समासिक-शब्दों की रचना करना और समास-वियोग करना

3. उपसर्ग : उपसर्गों को सामान्य ज्ञान, उनके संयोग से शब्दों की संरचना और शब्दों में विद्यमान उपसर्गों को अलग करना

4. प्रत्यय : प्रत्ययों का सामान्य ज्ञान, उनके संयोग से शब्दों की संरचना और शब्दों में विद्यमान प्रत्ययों को अलग करना

5. पर्यायवाची तथा विलोम शब्द

6. शब्द युग्मों का अर्थ भेद

7. वाक्यांश के लिए एक सार्थक शब्द

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

10. मुहावरे : दिये हुए मुहावरों का वाक्यों में प्रयोग द्वारा अर्थ स्पष्ट करना
11. लोकोक्षिपण : दी हुई लोकोक्षिपणों का वाक्यों में प्रयोग द्वारा अर्थ स्पष्ट करना

12. पारंपारिक शब्दावली : तकनीकी अंग्रेजी शब्दों के समानार्थक हिंदी शब्द

अनुभाग — ब
50 अंक

1. संक्षेपीकरण : दिये हुए गद्दी—अवतरण का एक तिहाई शब्दों में संक्षेपीकरण,
   उसका उचित शीर्षक तथा अवतरण से संबंधित प्रश्नों के उत्तर

2. वृद्धीकरण : किसी सुविदा, प्रशिक्षण कहने आदि का भाव—विस्तार

3. पत्र लेखन : व्यवसायिक एवं कार्यालय संबंधी पत्र

4. प्रारूप लेखन : निबंध, अधिसूचना, परिपत्र, ढापन, विज्ञापन आदि के प्रारूप की सामान्य जानकारी

5. अनुवाद : दिये हुए अंग्रेजी अवतरण का हिंदी अनुवाद

अनुभाग — स
20 अंक

1. निबंध लेखन : किसी सम—सामाजिक अथवा सामान्य विषय पर निबंध
   (शब्द सीमा : 500 शब्द)
• Development Processes: Inter relationship between social, economic, scientific and technological factors for development. Development criteria; gross national product, energy consumption.
• Rural economy, poverty, unemployment, exodus to urban areas. Land acquisition act.
• Financing methods of infrastructure projects-BOT, PPP etc., Case studies of recent projects in Rajasthan-Refinery, IIIT, NHAI Highway, Dedicated Freight Corridor, Metro Rail Project.
• Technology for rural and Desert Areas, Characteristic of desert areas, Thar desert, desertification and its control, sand dunes stabilisation.
• Rural energy needs, Deforestation, Modern Solar appliances, Challenges in Solar Power and Wind Power Generation and their Connection to Grid.
• 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.
• PMGSY Project. Right to Information act-its provisions.
• Technology Assessment and Transfer: Criteria for assessment and selection of technology, appropriate technology concept, technology transfer and development.
• 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. Health problems, challenges and their remedies due to some industry, textile industry, coal based thermal power plants and refinery cum petrochemical complex in Rajasthan. Challenges and utilisation of industrial by products (Like Flyash) in Rajasthan.
• 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. Carbon footprint of technologies, carbon credit system.
• Dumping of Radioactive waste-methods and monitoring. Effect on health.
• Development of Science and Technology: Information technology application in Project Designing, Project evaluation programme, implementation and monitoring.

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: Boussinesg'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.


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 planner 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. Reinforce cement 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 grider bridges and with lateral bracings.

Subject- CIVIL ENGINEERING - II

Maximum Marks: 200


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.


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.


Miscellaneous: Damp proof course, anti-termite treatment, sill, coping and corbeling.

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.


Shallow foundation: spread foundation, combined footing and strap footing, Mat or Raft Footing.


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.


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.

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.


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.


Subject- ELECTRICAL ENGINEERING - I

Maximum Marks: 200


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.


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.


Communication: Generation and detection of AM and FM, noise behaviour of AM and FM systems.


Subject- MECHANICAL ENGINEERING - I

Maximum Marks: 200

1. **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.

2. **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 recrystalization, 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.

3. **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.

4. **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.

5. **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.
1. **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.

2. **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.

3. **FLUID MECHANICS AND FLUID MACHINES**:


**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**:


- **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.
Subject- AGRICULTURAL ENGINEERING - I

Soil and Water Conservation: - Forms of Precipitation, hydrologic cycle, point rainfall analysis, frequency analysis. Water shed - definition and concept, agricultural watersheds, prediction of peak runoff, factors affecting runoff. Hydrograph, concepts of unit and instantaneous hydrographs. Erosion-type, affecting factors, damages 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 its design. Design of gully control measures including permanent structures i.e. chute spillway, drop spillway, drop inlet spillway, retards and stream bank erosion, flood routing, flood amelioration through soil and water management in upstream zone, mechanics of wind and water erosion, wind erosion control, water harvesting structures i.e. Khadin, Tanka, Nadi and Anicut.

Irrigation – Soil-Water- Plant relationship, permeability, infiltration, percolation, water requirements of crops and irrigation scheduling, direct and indirect methods of soil moisture measurements. Measurements of irrigation water-Orifice, Weirs, Notches, Parshall flumes, H-flumes etc. Water conveyance and control, design of field channels and canals, Lacey and Kennedy theories, Most economical channel cross section. Underground pipe line structures and their design. Irrigation methods, their hydraulics and design viz – Border, Furrow, Flood, Drip and Sprinklers methods, concepts in irrigation efficiencies.

Drainage : Benefits of drainage, hydraulic conductivity, drainable porosity, drainage Coefficient. Surface drainage, drainage of flat and sloppy lands. Design of open ditches, their alignment and construction. Design and layout of sub surface drains, depth and spacing of drains and drainage outlets, installation of drains and drainage wells, drainage of salt affected areas.

Pumps :- Design, construction, performance characteristics, selection, installation, working principle and maintenance of reciprocating pump, centrifugal pump, turbine pump, submersible Pump, jet pump, air lift pumps and hydraulic ram.

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, Design of well screen, well development.

Surveying, Leveling and Land Development :- Linear Measurements, different surveying devices and methods, land grading and leveling, contouring and terracing, each work estimation, Land Development Budgeting, earth moving machinery.
Subject- AGRICULTURAL ENGINEERING - II

**Farm Power** – Classification of Internal combustion (IC) engines terminology, Otto, Diesel cycle, basic IC engine components and functions, fuels and fuel supply system, lubrication system. Cooling system and governing system. Types of tractors, Transmission system – clutch, gearbox, brakes, PTO, differential. Mechanics of tractor chassis, principles of traction, steering system, hydraulic system and selection of tractors.

**Farm Machinery**: Farm mechanisation, tillage and tillage implements, types of hitching systems. Sowing and planting equipment and their calibration, Precision planting. Types of sprayers & dusters and its calibration. Selection and operation and principles of harvesting and threshing machines, reapers, combines and thresher. Cost analysis of farm equipment and related numerical problems.


**Farm electrification and Machine**: AC-DC Machines, DOL starter, Transformer, 3-phase Induction Motors and Alternators, Transmission and distribution of electricity. Selection, Installation & care of electric motors on farms. Selection and types of wiring based on Indian Standards and design of wiring systems. Rural electrification programmes.

**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. Integrated rural energy planning and development.

**Renewable Energy**: Solar Radiation – its measurement, solar thermal devices and gadgets i.e. solar cooker, solar water heater, solar dryer, solar refrigeration and air conditioning etc. Solar photovoltaic devices i.e. solar lantern, street light, power pack. Bio energy conversion, production and utilization, Biogas – type, classification and design of biogas plants. Biomass gasification and gasifier alcoholic fermentation (Ethanol and Methanol Production), wind energy conversion process i.e., water pumping, wind mills and aero generator.