

## **Scheme for the Assistant Engineer Combined Competitive Examination, 2024**

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 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**

<b>COMPULSORY PAPER</b>	<b>MAX. MARKS</b>	<b>TIME</b>
General knowledge & General Science including General knowledge of Rajasthan its Geography, Economy and culture	200	2 hrs

### **SECTION – B**

<b>S.No.</b>	<b>Name of Optional Paper</b>	<b>Max. Marks</b>	<b>TIME</b>
<b>(any one paper to be opted by candidate)</b>			
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.

	<b>Compulsory Subject</b>	<b>Maximum Marks</b>
Paper – I	Hindi	100
Paper – II	Social aspects of Engineering	100

	<b>Optional Subject</b>	<b>Maximum Marks</b>
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 marks for each papers)

**List of optional subjects:-**

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.

**Note - 1: The Commission shall not recommend any candidate for the State Engineering Services, who has failed to obtain a minimum of 50% marks in the aggregate.**

**Note - 2: The Commission shall, in case of Woman Candidates, candidates belonging to the Backward Classes, More Backward Classes, Economically Weaker Sections, Scheduled Castes and the Scheduled Tribes recommend the names of such candidates upto the number of vacancies reserved for them from amongst those who have qualified for interview, even if they fail to obtain the aggregate marks prescribed under Note – 1.**

# **Syllabus and scope of papers**

## **Preliminary Examination**

### **Compulsory Paper- General Knowledge & General science**

#### **History, Art, Culture, Literature, Tradition & Heritage of Rajasthan-**

- Pre-historical sites of Rajasthan- from Palaeolithic to Chalcolithic, Bronze and Iron Age. Rock art.
- Historical Rajasthan: Important historical centres of Early Christian Era- Malawa, Yodheya, Sibi and Matsya. Society, Religion and Culture in Ancient Rajasthan.
- Political and Cultural achievements of prominent rulers of major dynasties - Guhila, Pratihara, Chauhan, Parmar, Rathore, Sisodiya and Kachchawa. Administrative and Revenue System in Medieval Rajasthan.
- Emergence of Modern Rajasthan: Agents of Social Awakening in Rajasthan during 19<sup>th</sup>-20<sup>th</sup> Centuries. Political Awakening: role of newspapers and political institutions. Tribal and Peasant movements in 20<sup>th</sup> century, Praja Mandal movements in various princely states during 20<sup>th</sup> century. Integration of Rajasthan.
- Architectural Tradition of Rajasthan- temples, forts, palaces and man- made water bodies; Various schools of paintings and handicrafts.
- Performing Art: Classical Music and Classical Dance; Folk Music & Instruments; Folk Dances & Drama.
- Language & Literature: Dialects of Rajasthani Language. Literature of Rajasthani language and Folk literature.
- Religious Life: Religious Communities, Saints, warrior-saints and Sects in Rajasthan. Folk Deities of Rajasthan.
- Social Life in Rajasthan: Fairs and festivals; Social customs, traditions, attires and ornaments.
- Leading Personalities of Rajasthan.

#### **Ancient & Medieval Period:**

- Cultural Foundations of India - Indus and Vedic Age; Religious ideas of 6<sup>th</sup> Century BC- Buddhism and Jainism.
- Achievements of prominent rulers of major dynasties: Maurya, Kushan, Satavahan, Gupta, Chalukya, Pallava and Chola.
- Literature in Ancient India: Sanskrit, Prakrit and Tamil.
- Sultanate Period: Achievements of prominent Sultanate Rulers. Cultural achievements of Vijaynagar empire.
- Mughal Period: Political challenges and reconciliation- Afghan, Rajput, Deccan States & Maratha.
- Development of Art & Architecture during medieval period.
- Religious & Literary contribution of Bhakti & Sufi movement.

## **Modern Period (from early 19th century to 1964):**

- Evolution of Modern India & Emergence of Nationalism: Intellectual awakening; Press; Western education. Socio- religious reforms during 19<sup>th</sup> century: various leaders and institutions.
- The Freedom Struggle & Indian National Movement- its various stages, streams and important contributors, contributions from different parts of the country.
- Post-Independence- Nation Building: Development of science and technology in India.

## **Geography of India and Rajasthan**

### **A. India**

Major Physiographic characteristics, Climate, Soil and Natural Vegetation, Agriculture: types, Major Industries: Iron and Steel, Cotton Textile, Sugar, Paper, Petro-chemical and latest trends in Industries, Population: Growth, Distribution, Density and Sex-ratio, Environmental Problems and Ecological Issues.

### **B. Rajasthan**

Physiography, Rivers and Lakes, Climate, Soil and Natural Vegetation, Irrigation Projects, Livestock, Minerals, Demographic characteristics, Industries, Tourism

## **Indian Constitution, Political System & Governance**

- Indian Constitution: Philosophical Postulates- Constituent Assembly, Salient features of Indian Constitution, Constitutional Amendments.
- Preamble, Fundamental Rights, Directive Principles of State Policy. Fundamental Duties, Citizenship.
- **Indian Political System:** President, Prime Minister and Council of Ministers, Parliament, Supreme Court & Judicial Review.
- Election Commission of India and electoral reforms in India, NITI Aayog. Central Vigilance Commission, Lokpal, National Human Rights Commission.
- Political Dynamics in India-Caste, Class, Labour, Farmers, Gender, Religion, Language and Ethnicity, Naxalites and Terrorism; Federalism, Regionalism and National Integration.

## **Political and Administrative System of Rajasthan**

- State Political System: Governor, Chief Minister and Council of Ministers, Legislative Assembly, High Court.
- Administrative System: Chief secretary, District Administration, Local Self Government, Panchayati Raj Institutions.
- Institutions: Rajasthan Public Service Commission, State Human Rights Commission, Lokayukt, State Election Commission, State Information Commission.

## **Indian Economic Development and Planning-**

- Major Sectors of the Economy: Agriculture, Industry, Service and Trade Sectors - Current Status, Issues & Initiatives. Economic Reforms: Liberalization, Privatization, Globalization and their Impact. Niti Aayog. Latest Budget of Union Government. Environment and Sustainable Development: Sustainable Development Goals, SDG Index.
- **Economy of Rajasthan:** - Position of Rajasthan in Indian Economy. Food and Commercial Crops of Rajasthan, Agriculture based Industries, Major Irrigation and River Valley Projects, Projects for the Development of the Desert and Wastelands. Indira Gandhi Canal Project, Growth and Location of Industries, Industrial raw materials. Mineral based Industries, Small-scale and Cottage Industries, Export items, Rajasthani Handicrafts. Role of different Corporations in Industrial Development. Cooperative Movement. Tourism Development in Rajasthan. Major Economic Problems of Rajasthan and Obstacles in Economic Development. Current Budget of Rajasthan. Commercial Banks and other Financial Institutions in Rajasthan.

## **Science and Technology**

- General appreciation and understanding of science which includes matters of everyday observations and experiences.
- Computers, Information and Communication Technology.
- Defence Technology, Space Technology and Satellites in Indian perspective.
- Nanotechnology, Biotechnology and Genetic Engineering.
- Human Health, Diseases, Food and Nutrition.
- Environmental Changes and Environmental Impact Assessment (EIA).
- Remote Sensing and GIS.

## **Reasoning and Mental Ability**

- Number/Letter Sequences, Coding/Decoding, Cubes and Dice, Blood Relations, Analytical Reasoning.
- Real and Complex Numbers, Percentage, Time and Work, Perimeter and Area of Plane Figures, Surface Area and Volume of Cylinder, Cone, Sphere and Cuboid.

## **Current Affairs**

### **Rajasthan: -**

- Major government scheme, policies, programmes and other initiatives.
- Persons, Places, Events, Institutions, Departments, Reports, Awards etc. in news.
- Major trends of Economic survey and Budget of Rajasthan state.
- Current issues related to economic development and political dynamics of State.
- Games & Sports activities, Awards at State level.

### **National level & International Level: -**

- Persons, Awards, Places, Events, Institutions, Organisations in news.

## Optional Papers (Preliminary Examination)

### CIVIL ENGINEERING

#### **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 racking. 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, Glass, Plastics, Steel, FRP, Ceramics, Aluminium, Fly Ash, Basic Admixtures, Plain and reinforced Cement Concrete, Bitumen.

#### **B. SURVEYING**

Leveling, Use of Theodolite, Total Station, 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, Basics of Remote Sensing, Global Positioning System, Geographic Information System, Digital Elevation Method.

#### **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-relationships, 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, 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. Properties and uses of geosynthetics.

#### **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, couple (moment).

Theory of simple bending. Shear Stress, torsion, shear centre, Influence lines for determinate structures,

Deflection of cantilever, simply supported fixed and continuous beams. Analysis of Determinate and Indeterminate structures for axially loaded members, beams, frames pin jointed- Plane and space frames.

#### **E. STEEL STRUCTURES**

Provisions of latest versions of IS : 800 and 875, Limit State Design, Design of bolted connections, welded connections, Design of axially and eccentrically loaded tension members, Design of axially and eccentrically loaded compression members, Design of beams, Design of column bases (slab base and gusseted base), Design of plate girder, gantry girder, Design of roof trusses, Concepts of Plastic theory.

#### **F. REINFORCED CONCRETE STRUCTURES**

Provisions of latest IS: 456, design of beams singly and doubly reinforced, design of flexure and shear reinforcement. Serviceability criteria, Design for bond, anchorage and development length, 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. Provisions of latest IS: 3370, Reinforcement in overhead, ground supported and underground water tanks.

#### **G. FLUID MECHANICS INCLUDING HYDROLOGY AND IRRIGATION**

Properties of fluids, Hydraulic pressure at a point and its measurement. total pressure and centre of pressure on plane and curved immersed surfaces, 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, Momentum and angular momentum principles as applied to fluid in a control volume, applications of jets, Viscous flow, concept of drag, flow through pipes.

Dimensional analysis, Model similitude, Model scales, Physical modeling, Computational hydraulics- theory and applications, Momentum and energy equations.

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

## **H. PUBLIC HEALTH ENGINEERING**

Water demand 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.

Characteristics of waste water- BOD, COD, DO and TOC, Layout of sewerage systems. Primary, secondary treatments, sequencing batch reactor, trickling filters, lagoons and other treatment units and their design criteria. Flushing of sewers; sewage treatment; rural water supply and sanitation, classification of solid waste.

## **I. HIGHWAY AND BRIDGES**

Principles of highway planning; classification of road land width, building line, center line, formation width, terrain classification.

Geometric Design: 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.

Rigid pavements: Application of tie and dowel bars

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

Highway construction and maintenance of different types of roads. Need for highway drainage and arboriculture.

Highway bridges: Provisions of latest versions of IRC:5, IRC:6, IRC:21.



## ELECTRICAL ENGINEERING

**Electrical Circuits:** Circuit elements, Voltage & Current Sources, KCL and KVL Analysis, Network topology, Nodal and Mesh analysis. Basic Network theorems for AC and DC circuits, Network Functions: poles and zeros. Driving point and transfer functions, Response of networks to standard input signals. Elementary network synthesis, different type of network parameters, signal flow graphs, Two-port networks, Interconnection of two port Network, Theorems in transform domain: Fourier series, Laplace transforms and their applications. Frequency response, Resonant circuits and applications, Steady state response with sinusoidal input. Three-phase balanced and unbalanced networks, Transient response: Transient analysis of RL, RC and RLC circuits, Basics of magnetically coupled circuits.

**Field Theory:** Electrostatics and electrical fields, Stoke's theorem, Laplace's and Poisson's equations, Magnetostatics and magnetic fields, Field in conductors and in magnetic materials, field in dielectrics, Maxwell's equations in time varying fields.

**Electrical Materials:** Elementary Concepts, Classification of materials on the basis of permanent magnetic dipoles and conductivity, Electrical and electronic behaviour of materials, Dielectric Properties of insulators in static and alternating fields, Phenomenon of polarization and superconductivity, Applications of magnetic, conducting, dielectric & insulating materials.

**Electrical Measurement and Instrumentation:** General principles of measurement: Units & dimensions, Types of errors, Standard 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.

**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., flip-flops and their applications.

**Digital Electronics:** Switching circuits, Boolean algebra and logic gates. Memories, Sample and hold circuits. Logic circuits including DTL, TTL, ECL, MOS, CMOS, Digital ICs. Communication: generation, Detection of AM & FM noise, Behaviour of AM & FM systems.

**Microprocessor systems and computer:** Fundamentals, Microprocessor architecture 8085, Instruction set and simple assembly language programming, Interfacing of peripheral devices such as General Purpose I/O, memory devices, Applications of

microprocessors. Basic layout of digital computers, input-output devices, memory organisations, algorithms, flowcharts.

**Power Electronics:** Power semiconductor devices, triac, GTO, MOSFET, Thyristor. Static characteristics and triggering circuits, Clipping, Clamping, A.C. to D.C. Converters, choppers. Controlled and uncontrolled power rectifiers, Bridge converters, multivibrators, Oscillators.

**Control System:** Open and closed loop systems: Block diagrams and signal flow graphs, Transfer function models of linear time-invariant systems, Response analysis in time and frequency domain; steady state error analysis. Concept of Stability, Routh-Hurwitz Criteria, Nyquist criteria, Relative Stability analysis, Bode plots, gain margin, phase margin.

**Electrical Machines:**

*DC Motors:* Construction, Characteristics & Applications of shunt, Series & compound motors. Torque, Efficiency and testing. *DC Generators:* Construction, Characteristics & Applications of shunt, Series & compound generators. EMF equation, Efficiency & testing.

*Transformers:* Construction, equivalent circuit, Losses, Efficiency, All-day-efficiency, Voltage regulation, Parallel operation.

*Induction Motors:* Three-phase induction motors: Construction, Torque, Equivalent circuit, Torque-slip characteristic, Losses, Efficiency, Speed control methods, Braking. Single-phase induction motors: Double revolving field theory, Starting methods.

*Alternators:* Construction, EMF equation, Winding factor, Armature reaction, Synchronous reactance, Voltage regulation, Efficiency, Parallel operation, Synchronization

*Synchronous Motors:* Starting, Torque, Hunting & Damping, Power-angle Characteristic, V-curves

**Power systems:** Generation: thermal, Hydro, Nuclear generation; Non-conventional energy sources. Transmission & Distribution. Transmission line parameters – Resistance, Inductance and capacitance calculation, Performance of short, medium and long lines. Neutral earthing & grounding. Underground Cables. Corona & its effects and remedial measures. Basic idea of power system stability & its types. Insulators, introduction to HVDC transmission. Switchgear & protection: theories of arc extinction. Comparative merits of minimum oil, bulk oil, air break, air blast & SF6 circuit breakers. Causes and consequences of fault currents. Current 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, Friction, Brakes and dynamometers, Gears and gear trains, Governors, Static and dynamic balancing, Longitudinal, Transverse and Torsional vibration.
2. **Machine Design:** Manufacturing Considerations in design, Design for strength, Design of Members in bending, Failure theories, Design of members in torsion, Design of threaded fasteners, Design of curved beams.
3. **Material Science:** Crystal structure, Space lattice, Crystal imperfection, Miller indices, Coordination number, Packing efficiency, Phase diagrams, Plain carbon steels and alloy steels, Cast iron, Light metals and alloys, Heat treatment of steel, Non-ferrous materials, Plastics, Polymers, Rubber.
4. **Manufacturing Processes:** Pattern making, Moulding, Casting, Joining processes *viz.* Arc and Gas welding, Brazing and Soldering, Metal forming processes *viz.* Drawing, Extrusion, Forging, Piercing and Rolling, Basic machine tools *viz.* Lathe, Shaper, Drilling, Milling, Planer, Grinder, Theory of metal cutting and cutting tools, Modern machining methods, Flexible manufacturing system.
5. **Industrial Engineering and Management:** Types of business organization, Principles and elements of management, Organization charts, Elements of costing, Break even analysis, Types of budget & budgetary control, Statistical quality control, TQM, Time & Motion study, Plant location & layout, Material handling, Project management, Production planning & control, Supply chain management, Lean management, Industry-4.0.
6. **Thermal Engineering:** Basic concepts of thermodynamics, Laws of thermodynamics and their application to different flow and non-flow systems, Gas and Vapour power cycles, Conduction, Convection and Radiation, Dimensional analysis, Boiling & condensation, Heat exchangers.
7. **Refrigeration and Air-conditioning:** Air refrigeration cycles, Vapour compression refrigeration system, Vapour absorption refrigeration systems, Expansion devices, Refrigerants and their properties, Psychrometric properties and processes, Human comfort, Cooling load calculation.
8. **Fluid Mechanics and Machines:** Fluid properties, Kinematics and dynamics of fluid flow, Laminar and Turbulent Flows, Flow through pipes, Boundary layer, Impact of jets, Hydraulic pumps and turbines.
9. **Power Generation:** SI and CI engines, Combustion phenomenon, Fuel injection system, Steam power plant, Hydroelectric power plant, Introduction to Nuclear power plant, Biogas power plants, Solar, Wind, Geothermal and Tidal energy resources, Power plant economics.

## AGRICULTURAL ENGINEERING

### **Surveying, Levelling and Land Development: -**

Linear Measurements, different surveying devices and methods, land grading and levelling, contouring and terracing, earth work estimation, land development budgeting.

### **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.

### **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.

### **Farm Power and Machinery –**

Classification of Internal combustion (IC) engines, engine terminology, Otto, diesel & dual cycle, engine components, Fuel supply system, Lubrication system, cooling system and governing system, steering system, hydraulic system. Types of tractors, clutch & brakes, power transmission system. Traction theory, mechanics of tractor chassis, tyres and selection of tractors. Farm Machinery: Tillage & objectives, primary and secondary tillage equipment, ploughing methods. Sowing and planting equipment and their calibration, intercultural operation and weeders, Selection and calibration of sprayers and dusters, Principles, selection and operation of harvesting and threshing machinery.

Measurement of draft & field capacity, field efficiency, cost analysis of farm power & equipment and related numerical problems.

**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, water activity. Types of evaporators, steam economy. Refrigeration and cooling load calculation. Various size reduction theories and milling process for Rice, Maize, Wheat and Pulse. Parboiling of wheat and paddy. Grains storage structures, theory and their design requirement. Principles of food preservation and thermal processing.

**Farm electrification and rural housing: -**

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, village roads and drainage system, waste disposal and sanitary structures, material and cost estimation in construction.

**Renewable Energy:**

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. Biogas: types & design of biogas Plant. Biomass gasification and gasifiers, wind energy conversion process i.e., wind mills for water pumping, electricity generation.

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