

**Syllabus and Scope of papers for the Assistant Engineer
Combined Competitive Examination, 2024**

Main Examination

अनिवाय विषय (01) – हिन्दी

अधिकतम अंक: 100

अनुभाग – अ :

30 अंक

1. संधि
2. उपसर्ग
3. प्रत्यय
4. विलोम शब्द, पर्यायवाची शब्द
5. समश्रुत भिन्नार्थक शब्द युग्म
6. वाक्यांश के लिए एक सार्थक शब्द
7. शब्द शुद्धीकरण
8. वाक्य शुद्धीकरण
9. मुहावरे/लोकोक्तियाँ : वाक्य प्रयोग द्वारा अर्थ स्पष्ट करना
10. पारिभाषिक शब्दावली : तकनीकी अँग्रेजी शब्दों के समानार्थक हिन्दी शब्द

अनुभाग – ब

50 अंक

1. संक्षिप्तीकरण : गद्य-अवतरण का उचित शीर्षक, एक तिहाई शब्दों में संक्षिप्तीकरण, तथा अवतरण से संबंधित प्रश्न का उत्तर
2. वृद्धीकरण : सूक्ति/ प्रसिद्ध कथन/काव्य पंक्ति का भाव-विस्तार
3. पत्र लेखन : सामान्य कार्यालयी पत्र, कार्यालय आदेश, अर्धशासकीय पत्र, अनुस्मारक
4. प्रारूप लेखन : निविदा, अधिसूचना, परिपत्र, विज्ञप्ति
5. अनुवाद : अँग्रेजी अवतरण का हिन्दी अनुवाद

अनुभाग – स

20 अंक

निबंध लेखन – किसी सम-सामयिक अथवा सामान्य विषय पर निबन्ध (शब्द सीमा 400 शब्द)

Compulsory Paper (02) – SOCIAL ASPECTS OF ENGINEERING

Maximum Marks: 100

Development Processes, Rural Economy, and Indian Ethos:

Development Processes: Inter relationship among social, economical, environmental, scientific and technological factors for development. Development criteria; Gross National Product (GNP), Gross Value Added (GVA), energy consumption, carbon footprint, carbon credit system.

- Challenges in the rural economy: Poverty, Unemployment, Malnutrition, Inadequate Sanitation, Infant Mortality, Insufficient healthcare infrastructure, Exodus to urban areas. Deforestation, Land acquisition.
- Technology catering to the needs of Rural and Desert Areas: Sustainable Water Management and Irrigation, viz Drip Irrigation Systems, Rainwater Harvesting, Solar-Powered Desalination; Renewable Energy Solutions viz Solar Power, Wind Power, Biogas Systems; Agricultural Innovations viz Precision Agriculture, Climate-Resilient Seeds, Agro-forestry. Soil and water conservation, water harvesting, watershed planning. Thermal comfort aspects of housing Transport in rural and desert areas, Drought, Famine and Disaster management. Desertification, Sand Dunes Stabilization.
- **Indian Ethos in Development:** Concepts of ‘Sarvodaya’ (welfare for all), ‘Antyodaya’ (Last mile delivery) and ‘Swadeshi’ (self-reliance) in rural development.
- Promotion of Human values viz. **Empathy, Dignity, Fraternity, Harmony, Integrity, Honesty, Probity and Universal Accommodation.**

Globalization, Economic Growth, Industry 4.0, and Sustainable Infrastructure:

Globalisation of Economy: World Trade Organization (WTO), trade related Intellectual Property Rights (TRIPS), SDGs, Quality Management System, Optimisation of Human, Capital, Intellectual and Material resources.

- Financing methods of infrastructure projects-BOT, BOO, BLT, HAM, DBFM, PPP, Turnkey Projects etc., Case studies of recent projects in Rajasthan-Refinery, IIIT, NHAI Highway, Dedicated Freight Corridor, Metro Rail Project. Eastern Rajasthan Canal Project (ERCP), *Bharatmala* Pariyojana, PMGSY Project.
- **Role of Artificial Intelligence and Blockchain Technology in the Economic Growth of India in general and the State of Rajasthan in particular.**

- **The role of Industry 4.0's** in economic transformation of the local economy.
- **Building Sustainable Infrastructure and Smart Cities & Villages.**

Project Planning, Appraisal & Feasibility Study:

- Techno Economic Feasibility studies, Project planning and control, Use of CPM and PERT, **Resource Allocation , Resource Levelling and Resource Smoothing, Application of AI in Project Management.**
- Fixed and variable cost, IRR (Internal Rate of Return), Cost-benefit analysis, NPV (Net Present Value) Break even analysis, Depreciation, Life cycle costing. Software applications in life cycle cost analysis. Project Monitoring by SAP, Tally ERP and statistical software.

Environmental Degradation, Circular Economy, and Sustainable Development:

- Environmental degradation due to energy production, transport, industries, mining and intensive agricultural practices. Control of air, water, and noise pollution. Hazards of environmental pollution.
- Environmental Challenges owing to local industries viz Stone, Mineral processing, Textile, Cement, Coal based thermal power plants, refinery cum petrochemical complex etc. in Rajasthan.
- Bio-Diversity impediments due to indiscriminate usage of renewable resources.
- **Circular Economy:** Principles and applications of 8 R's in Indian industry (Reduce, Refuse, Reuse, Re-Purpose, Repair, Recycle Right, Remove and Rally).
- Risk mitigation, transfer and adaptation for sustainable life style for environment (LiFE).

Innovation for development of the Society:

- Development of start-up eco-system at the grass- root level.
- Engaging academia, industry and other stake holders to build innovation driven society.
- Promoting out of the box & critical thinking to prescribe solutions to address local challenges.
- Intellectual property rights to strike a balance between fostering innovation and social welfare.
- Promoting use of IT and **filling the gaps in digital divide between Rural & Urban population.**
- **Role of social media in rural development.**

OPTIONAL SUBJECTS (MAIN EXAM)

CIVIL ENGINEERING - I

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 and 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 net 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 and 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 kinematic indeterminacy, Energy theorems, Stiffness and flexibility methods for analysis of structures, methods of consistent deformation, slope deflection and moment distribution. Analysis of beams (including continuous) and portal frames, Influence lines for statically determinate and indeterminate beams and planar trusses. Muller-Breslau Principle. Rolling loads on beams- shear force and bending moment due to concentrated loads, uniformly distributed loads- shorter and longer than span. Approximate methods for analysis of frames- Portal method, Cantilever method.

D. STRUCTURAL DESIGN-I:

Reinforce cement concrete: Limit state theory, Provisions of latest IS: 456, resistance to bending, shear, torsion, deflection. Design of singly and doubly reinforced beams, one way, two way and flat slabs, columns with axial load and uniaxial moment loading, footing, cantilever and counterfort retaining walls, ground supported, underground and elevated reservoirs- provisions of latest IS: 3370, Design of cantilever sheds, rectangular portal frames, spherical domes, dog legged staircase.

Pre-stressed Concrete: Properties of high strength concrete and high tensile steel, Analysis of prestressed members for axial load, flexure and shear, Pre-tensioning and post tensioning losses in pre-stress. Design of beams and slab, Provisions of latest IS: 1343.

E. STRUCTURAL DESIGN-II:

Steel structures: Limit state design, Provisions of latest IS: 800, Design of bolted and welded connections, Design of axially and eccentrically loaded tension and compression members, single and built-up sections, lacings and battens, connections and splices, plastic theory of analysis, design of beams, roof trusses, beam column connections, Column bases- Gusseted and slab base. Plate and gantry girders, through and deck type plate girder bridges and with lateral bracings.

F. STRUCTURAL DYNAMICS:

Analysis of Single degree of freedom systems- free and forced vibrations, undamped and damped vibrations.

CIVIL ENGINEERING - II

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.

Mathematical modeling: tools and techniques, advanced modeling applications to water resources and environmental engineering problems.

B. SURVEYING:

Distance Measurements: 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 subtense bars.

Angle Measurements: Principles of theodolite and compass, traverse adjustments.

Vertical 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 theodolites, methods of records and reducing, stadia reductions, use of level rods, contouring, drainage and watershed lines.

Methods of filling in details: 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 prismatical, trapezoidal and Simpson's method.

Advance surveying: Use of Total station, concepts of Global Positioning System, Geographical Information System and Remote Sensing,

C. CONSTRUCTION MATERIALS:

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, use of construction and demolition waste.

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 Bitumen, Bituminous concrete, Bituminous emulsions, Bitumen Mastic and Minerals fillers.

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.I. Steel sheet roofing, Asbestos cement sheet roofing, jack arch roofing, tile and thatch roofing, false ceiling.

Flooring: Cement concrete flooring, flag stone flooring, terrazzo mosaic flooring, Terrazzo tile flooring, Marble 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.

Construction Management: Management of construction, plants and equipment. Planning for construction using network analysis C.P.M. and PERT techniques.

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. Cropping patterns. Intensity of irrigation, Irrigation drainage 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.

Canals: Design of lined and unlined canals, Silt theories, Tractive force approach, Canal transition.

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

Storage Works: Elementary concepts of gravity and earthen dams. Forces acting on gravity dams. Structural behaviour, stability considerations and stress variation in gravity dams. Phreatic line and control of seepage in earthen dam.

Multi-purpose Projects: Compatibility of Multi-purpose uses. Data needed in planning of multi-purpose water resources projects. Reservoir planning, Environmental consequences of irrigation, issues related to large dams, rehabilitation and resettlement problems of irrigation projects. River linking projects, inter-state river water disputes and acts. Water logging, problems of alkalinity and salinity, Farm drainage and command area development works.

E. HIGHWAY ENGINEERING AND BRIDGES:

Survey, investigation and preparation of road project. Highway standard classification, land width, building line center line, formation width, terrain classification, pavement width.

Geometric Design: Camber, longitudinal gradients, sight distance, horizontal curve, super elevation, vertical curve, lateral and vertical clearances.

Design of Pavement: Flexible pavements, Rigid 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.

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, abutment and wing walls. Training work for bridges and protection works. Low cost bridges, causeway, timber bridges, suspension bridges. Provisions of latest IRC:5, IRC:6, IRC:21. Design of slab culverts and pipe 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 n 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.

Solid Waste Management: Classification and Treatment methods, Sanitary landfill, Medical waste management and disposal methods.

ELECTRICAL ENGINEERING – I

Maximum Marks: 200

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: Electrostatic and Magnetostatics: 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 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.

ELECTRICAL ENGINEERING - II

Maximum Marks: 200

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.

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.

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.

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.

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.

MECHANICAL ENGINEERING - I

Maximum Marks: 200

1. **Theory of Machines:** Kinematic analysis of mechanisms, Instantaneous centre of rotation, straight line mechanisms, Steering mechanisms, Hooke's Joint, brakes and dynamometers, Cams, Governors, Gears and Gear trains, Flywheel and turning moment diagram, Friction, Clutches, Balancing of rotating and reciprocating masses, Gyroscopic motion, Vibration analysis of free, damped and forced vibration of single degree of freedom, Vibration isolation and transmissivity.
2. **Materials Science:** Crystal structures, Space lattice, Miller indices, Crystal imperfections, Theory of work hardening and recrystallization, Concept of creep, Fatigue and fracture, Phase diagrams, Plain carbon steel, Alloy steels, Effect of alloying elements in steel, Heat treatment of steels, Cast Iron, Light metals and alloys, Powder metallurgy, Ceramics and composites, Plastic, Rubber and Polymers, Nano and Smart materials.
3. **Machine Design:** Manufacturing Considerations in Design, Factor of safety, Stress-strain relationship, Deflection in beams, Bending moment and shear force diagram, Columns and Struts, Eccentric loading, 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, Gears, Brakes, Clutches, Bearings, Thin and thick pressure vessels.
4. **Manufacturing Processes:** Foundry technology, Joining processes *viz.* Arc & Gas welding, shielded metal arc welding, GTAW, GMAW, SAW, ESW, Resistance welding (spot, seam, projection, percussion, flash types), Thermit welding, Brazing and Soldering, Metal forming processes *viz.* Drawing, Extrusion, Forging and Rolling, Basic machine tools *viz.* Lathe, Shaper, Drilling, Milling, Grinder and Planer, Jigs & fixtures, Theory of metal cutting and cutting tools, Modern machining methods *viz.* Abrasive and Water jet, Ultrasonic, ECM, EDM, LBM, Plasma arc machining, Flexible manufacturing system, Robotics, Computer integrated manufacturing, Additive manufacturing processes.
5. **Industrial Engineering:** Type of business organizations, Principle and elements of Management, Management philosophies of Taylor, Gilbreth, Fayol and Mayo, Management structure, Authorities and responsibilities, Organizational charts, Span of control, Time & motion study, Quality control, Work sampling, Make and buy decision, Game theory, Single server queuing model, Plant layout and Plant location, Material handling, Production planning and control, Project management, PERT, CPM, Resource levelling & Smoothing, Material Management *viz.* ABC Analysis, Basic EOQ models, MRP-I, MRP-II, ERP, Introduction to linear programming problems and Graphical method to solve it, Primal to dual conversion of linear programming problems, Value analysis, Supply chain management, Lean management, Industry-4.0, Labour legislation, Industrial Relations.

MECHANICAL ENGINEERING - II

Maximum Marks: 200

1. THERMAL ENGINEERING:

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, Dual Cycle, Brayton cycle with modifications, Ideal jet propulsion cycles.

Vapour Power Cycles: Carnot and Rankine cycles, Reheat and regenerative cycles, Reheat factor, Binary vapour power cycle, Combined gas-vapour power cycle.

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 shielding, 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: Classification 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 Mechanics: Fluids and their properties, Buoyancy and floatation, Kinematics and dynamics of fluid flow, Dimensional analysis, Laminar and turbulent flows, Flow through pipes, Boundary layer.

Fluid Machines: Centrifugal pumps: Constructional details, Manometric and overall efficiencies, Hydraulic turbines: Impact of jets, Classification and constructional features of Pelton, Francis and Kaplan turbines, Draft tubes, Cavitation, Specific speed, Velocity triangles, Efficiencies, Characteristic curves, Governing systems.

4. REFRIGERATION AND AIR-CONDITIONING:

Refrigeration: Basic refrigeration and heat pump cycles, Air refrigeration system, Vapour compression refrigeration, Vapour absorption system, Refrigerants, Refrigeration Equipment *viz.* Compressor, Condenser, Evaporator, Expansion devices, Water vapour refrigeration system, Vortex tube refrigeration system, Thermo electric refrigeration system.

Air-conditioning: Psychrometric properties and processes, Human Comfort: Mechanism of body heat losses, Factors affecting human comfort, Effective temperature, Comfort chart, Cooling Load Estimation and Selection of air conditioning apparatus: Internal heat gain, System heat gain, RSHF, ERSHF, GSHF, Cooling and heating load estimation, Year round air conditioning

5. ENERGY SYSTEMS:

Internal Combustion Engines: S.I. and C.I. engines, Combustion phenomenon, Combustion chambers, Fuel injection system, Supercharging, Performance parameters of I.C. engines, Engines emission and control.

Steam Turbines: Flow of steam through nozzles, Steam turbines, Velocity diagrams for impulse and reaction turbines, Degree of reaction, Compounding 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.

Steam Power Plants: High pressure steam boilers and accessories, plant layout, Fuel handling and firing, ash, smoke and dust removal, Fluidized bed combustion, 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 Hydroelectric plants, Modular nuclear power plants.

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

AGRICULTURAL ENGINEERING – I

Maximum Marks: 200

Soil and Water Conservation: -

Forms of 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, affecting factors, damages associated with erosion, assessment of actual annual soil loss 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, 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, earth work estimation, Land Development Budgeting, earth moving machinery.

AGRICULTURAL ENGINEERING– II

Maximum Marks: 200

Farm Power –

Classification of Internal combustion (IC), engines terminology, Otto, Diesel and Dual cycle, Basic IC engine components and functions. Fuels & fuel properties, fuel supply system. Lubricants & lubrication system. Coolants & cooling system. Governing system. Types of tractors, clutch, brakes, transmission system, PTO, differential. Traction theory, mechanics of tractor chassis, tyres and terminology of tyre, power steering system, hydraulic system. Selection of tractors and maintenance. Trouble shooting in tractors. Numerical problems on engine performance parameters.

Farm Machinery :

Farm mechanization, Tillage & its objectives, primary and secondary tillage equipment. Various 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. Introduction to precision farming and applications of agricultural drones.

Agricultural Processing:

Various size reduction machinery. Energy required in size reduction of agriculture material. Material handling equipment. Separation equipment-based on size, shape and surface characteristics. Heating and Cooling of food products, mode of heat transfer, different types of heat exchangers. Psychometric chart and its application in drying. Numerical problems on water activity. EMC and methods of its determination, Principles of drying and drying equipments, types of evaporators, single and multiple effect evaporator. Numerical problems on single effect evaporation. Refrigeration load calculation. Various milling process for Rice, Maize, Wheat and Pulses. Parboiling of wheat and paddy. Storage structures for grains and their design. Principles of food preservation and thermal processing.

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, Village roads and 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 gasifiers, alcoholic fermentation (Ethanol and Methanol Production), biodiesel, wind energy conversion process i.e., wind mills for water pumping, electricity generation.
