ANNEXURE-III

SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POSTS OF ASSISTANT EXECUTIVE ENGINEERS IN VARIOUS ENGINEERING SERVICES NOTIFICATION NO. 12/2022, DATED: 03/09/2022

Scheme of Examination

WRITTEN EXAMINATION (Objective Type)	No. of Questions	Duration (Minutes)	Maximum Marks
Paper-I: General Studies and General Abilities	150	150	150
Paper-II: Civil Engineering (Degree Level) **OR** Mechanical Engineering (Degree Level) **OR** Electrical and Electronics Engineering (Degree Level) **OR** Agricultural Engineering(Degree Level)	150	150	300
Total			**450**

Name of the Papers	Language Of Examination
PAPER-I: General Studies and General Abilities	Bilingual i.e., English and Telugu
PAPER-II: Concerned Subject	English Only

Syllabus

PAPER-I: GENERAL STUDIES AND GENERAL ABILITIES

1. Current affairs – Regional, National and International.
2. International Relations and Events.
3. General Science; India's Achievements in Science and Technology.
4. Environmental issues; Disaster Management- Prevention and Mitigation Strategies.
5. Economic and Social Development of India and Telangana.
6. Physical, Social and Economic Geography of India.
7. Physical, Social and Economic Geography and Demography of Telangana.
8. Socio-economic, Political and Cultural History of Modern India with special emphasis on Indian National Movement.
9. Socio-economic, Political and Cultural History of Telangana with special emphasis on Telangana Statehood Movement and formation of Telangana state.
10. Indian Constitution; Indian Political System; Governance and Public Policy.
11. Social Exclusion; Rights issues such as Gender, Caste, Tribe, Disability etc. and inclusive policies.
12. Society, Culture, Heritage, Arts and Literature of Telangana.
13. Policies of Telangana State.
14. Logical Reasoning; Analytical Ability and Data Interpretation.
15. Basic English. (10^{th} class Standard)

PAPER-II CIVIL ENGINEERING (DEGREE LEVEL)

1. **Building Materials And Construction:**

   Bricks– Types of Bricks, Indian standard classification, properties; Stones – Types of stones, classification, properties, dressing and polishing of stones; Methods of Quarrying; Cement – Different grades and types of cement, properties and IS specifications; Aggregates – coarse and fine aggregate, properties and IS specifications; Cement Mortar – Proportions of cement mortar for various applications; Concrete – Constituents of Concrete, Different grades of Concrete, mix proportioning using IS Code, Properties of fresh and hardened Concrete; Admixtures – Types of Admixtures.

2. **Strength of Materials And Theory of Structures:**

   Strength of Materials: Simple stresses and strains, elastic constants and relationship between them; Compound bars; Temperature stresses; Shear forces and bending moment diagrams for beams; Principal stresses and Mohr's circle of stress, Theory of bending and bending stresses; Shear stress distribution; Theory of torsion; Springs; Deflections of beams; Thin and thick cylinders;; Analysis of trusses, Betti-Maxwell theorem; Shear centre and unsymmetrical bending.

   Theory of Structures: Direct and bending stresses; Columns and struts; Strain energy method; Moving loads and influence lines; Arches and suspension bridges; Static and kinematic indeterminacy; Moment distribution, Slope deflection, and Kani's methods applied to continuous beams and portal frames; matrix methods of analysis.

3. **Cement Concrete and Steel Structures:**

   Concrete Structures: Materials, permissible stresses and IS Specifications; Working stress methods; Limit State Method - Stress Blocks parameters, design of Beams, Slabs, Columns and Footing; Design for Shear and Torsion; Design of Retaining Walls, Water tanks, and T-Beam Slab bridges; Yield line theory.

   Steel Structures: Properties of steel sections, permissible stresses, IS Specifications; Riveted and welded joints and connections; Design of simple and compound Beams and Columns, Column bases, Roof trusses, Plate and Gantry Girders; Plate Girder Lattice Girder Railway bridges, and Bearings. Plastic analysis.

   Pre-Stressed Concrete: Basic concepts, material for pre-stressing, losses in Pre-stress, classification of pre-stressing system; Analysis of PSC Sections.

4. **Fluid Mechanics and Hydraulics:**

   Fluid Properties; Measurement of Pressure - Manometers; Fluid Kinematics – Classification of Fluids, Stream function and Velocity potential, significance and use of Flownets, Fluid dynamics - Continuity equation, Bernoulli's equations and Impulse momentum equation; Laminar and Turbulent flow through pipes – significance of Reynolds number, Hagen – Poiseuille's equation, Darcy – Weisbach equation, Friction factor, Water hammer concepts; Compressible flow – Bernoulli's equation for Isothermal and Adiabatic conditions, Mach Number, Mach cone, stagnation properties; Steady uniform flow through open channels; Gradually varied flows – significance of Froude number, classification and computation of Flow profiles, Hydraulic jump, Surges; Boundary layer – Laminar and Turbulent Boundary layer, Boundary layer thickness, rough and smooth Boundaries, Boundary layer separation; Dimensional analysis and similarity laws; Hydraulic Turbines – classification, Velocity triangles, principles and design of reaction and impulse turbines; Centrifugal pumps – specific speed, work done and efficiency, characteristic curves.

5. **Hydrology and Water Resources Engineering:**

   Hydrological cycle; Rainfall – types and measurement, network design; Infiltration -Φ-index; Runoff – process, factors and determination of runoff, dependable yield; Floods – flood hydrograph, computation of flood peak using rational formula, unit hydrograph method and Gumbel's extreme value methods; Groundwater – types of aquifer and properties, Darcy's law, specific yield, steady radial flow to wells in confined and unconfined aquifers; Irrigation – types and advantages, soil water plant relationship, consumptive use, duty, delta, base period, crops and their water requirements; Single and multipurpose projects; Dams – classification, forces and design of Gravity dam and Earth dam; Spillways – types, energy dissipation, stilling basin, Appurtenances; Canals – alignment, Kennedy's and Lacey's theories, lining of Canals; Weirs – components, design of vertical drop and sloping glacis weir; Seepage forces – Bligh's Theory, Khosla's theory; Canal falls – types and design principles; Cross drainage works – classification and design principles of aqueducts; Hydropower principles – classification and components of Hydroelectric power plants.

6. **Environmental Engineering:**

   Water supply – objectives, rate of demand, population forecasts; Analysis of water – classification, design of coagulation, sedimentation, filtration, disinfection and softening processes; Methods of layout of distribution pipes – Hardy cross method; Waste water

engineering – systems of sewerage, hydraulic formulae and design of sewers, BOD, COD, self purification of natural streams, methods of sewage disposal; Treatment of sewage – principles and design of grit chamber, sedimentation tanks, trickling filters, activated sludge process, sludge digestion tanks, septic tanks; Municipal solid waste – characteristics, collection and transportation of solid wastes; Air Pollution – types and sources of pollutants, air quality standards; Noise pollution – Impacts and permissible limits, measurement and control of noise pollution.

7. **Transportation Engineering:**

   Highway Classification as per IRC; Highway alignment; Engineering Surveys; Geometric Design; Cross sectional elements of road; Gradient; Grade compensation; Traffic Surveys – speed, Volumes, origin and destination; Intersection – at grade and grade separated; Channelization; Rotary intersection; signal design – webstar method, traffic signs, pavement marking; Parking studies, accidental studies, pavement types, Factors considered for pavement design, flexible and rigid pavements design concepts.
   Railway Engineering: Permanent way, rails, sleepers, ballast; Creep, coning of wheel, rail fixtures and fastenings, super elevation, cant deficiency, curves, turnout; Points and crossings.
   Airport Engineering: Selection of site of Airport, runway orientation and design, wind rose diagram, basic run way length, correction to basic runway length.

8. **Soil Mechanics and Foundation Engineering:**

   Soil Mechanics: Physical properties of soils, Classification and identification, Permeability, Capillarity, Seepage, Compaction, Consolidation, Shear Strength, Mohr's circle, Earth pressure, Slope stability;
   Foundation Engineering: Site investigations, stress distribution in soils, Bearing capacity, Settlement analysis, Types of Foundation, Pile foundations, Foundations on expansive soils; swelling and its preventions; Coffer dams, Caissons, Dewatering, Bracing for excavations, Newmark charts, machine foundations.
   Engineering Geology: Mineralogy, Structural Geology, Groundwater Exploration methods; Engineering Geology applications for Tunnels, Dams and Reservoirs; Geological hazards and preventive measures.

9. **Estimation, Costing and Construction Management:**

   Abstract estimate: Detailed estimate – centerline, long & short wall method, various items of Civil Engineering works as per Indian Standard, General Specifications - Earth Work, Brick / Stone Masonry in Cement Mortar, RCC, Plastering in Cement Mortar, Floor finishes, white wash, colour wash; Standard schedule of rates, lead and lift, preparation of lead statement; Computation of earth work – Mid-ordinate, Mean Sectional area, Trepezoidal method, Prismoidal Rule; Approximate estimate – Plinth area and cubic rate estimate.

10. **Construction Management:**

    Types of construction projects, Tendering and construction contracts, project planning and network analysis – PERT and CPM.

11. **Surveying:**

    Principle and classification of surveying, chain surveying; Compass surveying; Levelling and contouring; Theodolite surveying; curves; Introduction and Fundamental concepts of electronic measuring instruments – EDM, Total station, components of GPS and basics of GIS.

PAPER-II MECHANICAL ENGINEERING (DEGREE LEVEL)

Section I: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; Friction, rolling friction, belt – pulley, screw jack, wedge, Trusses and Frames; Virtual work; Kinematics and Dynamics of Particles and Rigid Bodies in Plane Motion; Impulse and Momentum (Linear and Angular) and Energy Formulations; Impact.

Strength of Materials: Stress and Strain, Stress-Strain Relationship and Elastic Constants, Poisson's Ratio; Mohr's Circle For Plane Stress and Plane Strain; Thin Cylinders; Shear Force and Bending Moment Diagrams; Bending And Shear Stresses; Deflection Of Beams; Torsion Of Circular Shafts; Euler's Theory Of Columns; Energy Methods; Thermal Stresses; Testing Of Materials with Universal Testing Machine (UTM); Hardness And Impact Strength.

Theory of Machines: Displacement, Velocity and Acceleration Analysis of Plane Mechanisms; Dynamic Analysis of Slider-Crank Mechanism; Gears and Gear Trains; Flywheels, Gyroscope and Governors; Balancing of Reciprocating and Rotating Masses.

Vibrations: Free and Forced Vibration of Single Degree of Freedom Systems, Effect of Damping; Vibration Isolation; Resonance; Critical Speeds of Shafts.

Machine Design: Design For Static and Dynamic Loading; Failure Theories; Fatigue Strength; S-N Diagram; Design of Machine Elements such as Bolted, Riveted and Welded Joints, Shafts, Spur Gears, Rolling and Sliding Contact Bearings, Springs, Brakes and Clutches.

Section II: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid Properties; Fluid Statics, Manometry, Buoyancy, Forces on Submerged Bodies, Stability of Floating Bodies; Fluid Acceleration; Differential Equations of Continuity and Momentum; Bernoulli's Equation; Viscous Flow of Incompressible Fluids, Boundary Layer, Elementary Turbulent Flow, Flow Through Pipes, Head Losses in Pipes and Bends.

Heat-Transfer: Modes of Heat Transfer; One Dimensional Heat Conduction, Resistance Concept, Electrical Analogy, Fins; Unsteady Heat Conduction, Dimensionless Parameters in Free and Forced Convective Heat Transfer, Various Correlations for Heat Transfer in Flow Over Flat Plates and Through Pipes, Effect of Turbulence; Radiative Heat Transfer, Black And Grey Surfaces, Shape Factors, Network Analysis, Heat Exchanger Performance, LMTD and NTU Methods.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamics property, availability and irreversibility; thermodynamic relations.

Power Engineering: Air compressors-Reciprocating and rotary compressors;Rankine, Brayton Cycles with Regeneration, Inter cooling and Reheat.

I.C. Engines: Air-standard Otto & Diesel Cycles, Combustion in S.I. & C.I. Engines, Performance & Testing of internal combustion engines.

Refrigeration and Air-Conditioning: Vapour Refrigeration Cycle, Heat Pumps, Gas Refrigeration; Reverse Brayton Cycle; Moist Air: Psychrometric Chart, Basic Psychrometric Processes.

Turbomachinery: Pelton Wheel, Francis and Kaplan Turbines, Impulse and Reaction Principles, Velocity Diagrams.

Section III: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and Properties of Engineering Materials, Heat Treatment, Stress-Strain Diagrams for Engineering Materials, Iron-carbon diagram.

Metal Casting: Design of Patterns, Moulds and Cores; Solidification and Cooling; Riser and Gating Design.

Metal Forming: Plastic Deformation and Yield Criteria; Fundamentals of Hot and Cold Working Processes; Load Estimation for Bulk (Forging, Rolling, Extrusion, Drawing) and Sheet (Shearing, Deep Drawing, Bending) Metal Forming Processes; Principles of Powder Metallurgy.

Joining Processes: Principles (Gas, Arc, Resistance and Solid State) of Welding, Brazing,

Soldering; Adhesive Bonding.

Machining and Machine Tool Operations: Mechanics of Machining; Basic Machine Tools; Single and Multi-Point Cutting Tools, Tool Geometry and Materials, Tool Life and Tool Wear; Economics of Machining; Principles of Non-Traditional Machining Processes; Principles of Work Holding Devices, Principals of Jigs and Fixtures.

Metrology and Inspection: Limits, Fits and Tolerances; Linear and Angular Measurements; Comparators; Gauge; Interferometry; Form and Surface Finish Measurement; Alignment and Testing Methods; Tolerance Analysis in Manufacturing and Assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Production Planning and Control: Forecasting Models, Aggregate Production Planning, Scheduling, Materials Requirement Planning.

Inventory Control: Deterministic Models; Safety Stock Inventory Control Systems.

Operations Research: Linear Programming, Simplex Method Transportation, Assignment, Simple Queuing Models, PERT and CPM.

PAPER.II ELECTRICAL AND ELECTRONICS ENGINEERING (DEGREE LEVEL)

1. **Electric Circuits and Fields:** Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's, Superposition, Maximum Power Transfer and Reciprocity theorems; two-port networks, three phase circuits; Star, Delta connections, Measurement of power in 3-phase by two-wattmeter method; Fourier, Laplace and Z transforms; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.
2. **Electrical Machines:** Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto-transformer; energy conversion principles; DC machines - types, windings, generator and motor characteristics, losses and efficiency, armature reaction and commutation, starting and speed control of motors, tests; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of alternators, motor starting, characteristics and applications; servo motors.
3. **Power Systems:** Basic power generation concepts, Economic aspects, Types of Tariffs; transmission line models and performance; cable performance, insulators, Sag and Tension; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow study; voltage control; power factor correction; economic operation; Load Frequency Control; symmetrical components; symmetrical & unsymmetrical fault analysis; principles of over-current, differential and distance protection; Generator protection, Transformer protection, Feeder protection, static relays; circuit breakers; Power system stability concepts, swing equation, power angle curve, solution of swing equation, equal area criterion.
4. **Control Systems:** Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Nyquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.
5. **Electrical and Electronic Measurements:** DC, AC Bridges, potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; shunts, multipliers; instrument transformers; digital voltmeters, CRO; phase, time and frequency measurements using lissajous patterns; error analysis.
6. **Analog and Digital Electronics:** Characteristics of p-n junction diode, Zener diode, BJT, FET; amplifiers - biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers - characteristics and applications; simple active filters; VCOs and timers; Boolean Algebra, mizimizition of switching functions combinational and sequential logic circuits; schimitt trigger, multi vibrators Flip flops, counters and registers, sample and hold circuits; A/D and D/A converters; microprocessor basics.(8085 & 8086), architecture, programming and interfacing, 8051 mc BASICS (Architectures. Addressing modes and instruction set).
7. **Power Electronics** : Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits

commutation circuits; phase control rectifiers; bridge converters - fully controlled and half controlled; dual converters, principles of choppers, inverters, cyclo-converters and ac voltage controllers.

8. Electric Drives: Four quadrant operation, Types of loads, Energy loss during starting and braking of dc and ac motors, Types of braking in dc & ac motors, Basis concepts of converter and chopper fed dc drives; V/f control, static rotor resistance control and slip power recovery scheme of 3-phase induction motor drives.

9. Utilization: High frequency eddy current heating, dielectric heating, Arc furnace, electric arc welding & electric resistance welding, Illumination: Laws of illumination, MSCP, SV & MV lamps, Factory, street & flood lighting, Electric traction and track electrification, Speed-time curves, Tractive effort, Specific energy consumption, Mechanism of train movement, adhesive weight and coefficient of adhesion. DC motor series parallel control, energy saving.

PAPER-II AGRICULTURAL ENGINEERING (DEGREE LEVEL)

1. **Surveying and Levelling:**Classification and basic principles of surveying, Linear measurements. Chain surveying. Cross staff survey, Compass survey. Planimeter, Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Levelling difficulties and error in levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic Theodolite. Introduction to GPS survey

2. **Fluid mechanics and Open Channel Hydraulics**: Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time),Flow through Mouthpieces, Flow over Notches , Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

3. **Soil Mechanics:** Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards analysis, new mark influence chart. Seepage Analysis; Quick condition-two dimensional flow-Laplace equation, Velocity potential and stream function, Flow net construction. Shear strength, Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number.

4. **Strength of materials:** Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution methods.

5. **Building Construction and Cost Estimation:** Building materials, building components,design procedures and construction. Types of agricultural buildings and related needs, sloped and flat roof buildings, construction economics. Preliminary estimates and detailed estimates of buildings. Use of cost analyses for controlling design.

6. **Watershed Hydrology:** Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship. Hydrologic processes-Interception, infiltration. Evaporation - estimation and measurement. Runoff - measurement - discharge rating curve, estimation of peak runoff rate and volume - Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds Linear, aerial and relief aspects of watershed, stream order, drainage density and stream frequency. Hydrograph - components, base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations. Stream gauging, discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing, channel and reservoir routing. Drought classification, causes and impacts, drought management strategy.

7. **Groundwater, Wells and Pumps:** Movement of ground water, aquifers, wells, groundwater exploration techniques, tube well and gravel pack, well screen, development of well, groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method, well interference, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; pumps, performance curves, capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

8. **Irrigation and Drainage Engineering:** Measurement of irrigation water: weir, flumes and orifices and other methods; open channel water conveyance system, design and lining of irrigation field channels, on farm structures for water conveyance, control& distribution; Soil water plant relationships, consumptive use, GCA,CCA,duty, delta,base period,relationship between duty and delta, irrigation efficiency, crops and their water requirementunderground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work; soil water plant relationship, soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evaporation, transpiration, evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations, Water logging, causes and impacts, drainage, surface drainage coefficient, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table; derivation of Hooghoudt's and Ernst's drain spacing equations, design of subsurface drainage system; drainage structures, vertical drainage; mole drains; salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

9. **Sprinkler and Micro irrigation Systems:** Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency;Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps and fertigation.

10. **Soil and Water Conservation Engineering:** Soil erosion - Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI_{30} methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Engineering measures, Bunds and terraces. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion.

11. **Watershed Planning and Management:** Watershed characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, Watershed management, watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting - rainwater conservation technologies, water harvesting and recycling. Dry farming techniques, Integrated watershed management - agriculture and horticulture, non-arable lands,effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme. Participatory watershed management. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

12. **Water Harvesting and Soil Conservation Structures:** Water harvesting techniques. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Percolation pond, Design considerations of *nala* bunds. Soil erosion control structures. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway.

13. **Tractor Systems and Controls:** Study of clutch, Gear Box and differential system, need for a final drive,brake system, steering system. Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system. Tractor power outlets,PTO, PTO standards, types and functional requirements. Traction. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres, traction aids, tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Tractor as a spring-mass system. Ergonomic considerations and operational safety. Tractor testing. Deciphering the tractor test codes.

14. **Farm Machinery and Equipment:** Classification of farm machines. Machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage. Land reclamation and earth moving equipment. Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Sowing, planting & transplanting equipment. Seed drills, no-till drills, and strip-till drills. Planters, bed-planters and other planting equipment. Types of furrow openers and metering systems Calibration of seed-drills/ planters. Adjustments during operation. Materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines Plant protection equipment. Types of nozzles. calibration of sprayers and chemical application rates. Weeders. Fertilizer application equipment. Harvesting operations, mowers, shear type harvesting devices, cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Reapers, binders and windrowers.Hay conditioning, Threshing systems, Threshing drums. Threshers.Grain combines, Material flow in combines. Computation of combine losses. Chaff cutters.straw combines. Root crop diggers, Potato and groundnut diggers. Cotton harvesting mechanisms, Cotton pickers and strippers, functional components. Maize harvesting combines. Vegetables and fruit harvesting equipment and tools.

15. **Post Harvest Engineering of Cereals, Pulses and Oil Seeds:** Cleaning and grading, aspiration, scalping.Separators. Size reduction principles - Bond’s law, Kick’s law, Rittinger’s law. Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying theory,EMC determination, Psychrometric chart in drying, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd’s equation, Dryer performance, Methods of drying.Grain dryers. mixing theory. Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling,

different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking, single and twin-screw extruders. By-products utilization.

16. **Dairy and Food Engineering:** Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation.Properties of milk and milk products. Principles and equipment related to milk receiving, pasteurization, sterilization, homogenization, centrifugation and cream separation. Manufacture of cheese, *paneer*, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Thermal processing, canning, aseptic processing, Evaporation of food products: Evaporators, steam economy, multiple effect evaporators, vapour recompression, Drying of liquid and perishable foods: spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

17. **Fundamentals of Renewable Energy Sources:** Classification, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Solar Energy -Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy - Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of windmill rotors, Determination of torque coefficient, Induction type generators, working principle of wind power plant. Bio-energy - Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifiers, Biogas - biogas plants, biogas generation, design considerations.