# RECRUITMENT TO THE POST OF ASSISTANT ENGINEER IN THE OFFICE OF THE CHIEF ENGINEER, WATER RESOURCES DEPARTMENT, MEGHALAYA

## Syllabus for Written Examination

## PART I – GENERAL ENGLISH (100 marks)

## PART II – GENERAL KNOWLEDGE (100 marks)

## PART III – OPTIONAL SUBJECTS (ANY ONE – Objective – 100 marks)

## A. AGRICULTURE ENGINEERING

1. **Soil and Water Conservation:** Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation relationships and their measurement. Soil erosion control measures – biological and engineering including stream bank protectionvegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets and grassed waterways. Gully control structures – temporary and permanent – design of permanent soil conservation structures such as chute, drop and drop inlet spillways. Design of farm ponds and percolation ponds. Principles of flood control – flood routing. Watershed Management – investigation, planning and implementation – selection of priority areas and water shed work plan, water harvesting and moisture conservation. Land development – levelling, estimation of earth volumes and costing. Wind Erosion process – design for shelter belts and wind brakes and their management. Forest (Conservation) Act.

2. **Aerial Photography and Remote Sensing:** Basic characteristics of photographic images, interpretation keys, equipment for interpretation, imagery interpretation for land use, geology, soil and forestry. Remote sensing – merits and demerits of conventional and remote sensing approaches. Types of satellite images, fundamentals of satellite image interpretation, techniques of visual and digital interpretations for soil, water and land use management. Use of GIS in planning and development of watersheds, forests including forest cover, water resources etc.

3. **Irrigation and Drainage:** Sources of water for irrigation. Planning and design of minor irrigation projects. Techniques of measuring soil moisture – laboratory and in situ, Soil-water plant relationships. Water requirement of crops. Planning conjunctive use of surface and ground water. Measurement of irrigation water, measuring devices – orifices, weirs and flumes. Methods of irrigation – surface, sprinkler and drip, fertigation. Irrigation efficiencies and their estimation. Design and construction of canals, field channels, underground pipelines, head-gates, diversion boxes and structures for road crossing. Occurrence of ground water, hydraulics of wells, types of wells (tube wells and open wells) and their construction. Well development and testing. Pumps

types, selection and installation. Rehabilitation of sick and failed wells. Drainage causes of waterlogging and salt problem. Methods of drainage— drainage of irrigated and unirrigated lands, design of surface, sub-surface and vertical drainage systems. Improvement and utilization of poor quality water. Reclamation of saline and alkali soils. Economics of irrigation and drainage systems. Use of waste water for irrigation — standards of waste water for sustained irrigation, feasibility and economics.

4. **Agricultural Structures:** Site selection, design and construction of farmstead – farm house, cattle shed, dairy bam, poultry shed, hog housing, machinery and implement shed, storage structures for food grains, feed and forage. Design and construction of fences and farm roads. Structures for plant environment – green houses, poly houses and shade houses. Common building materials used in construction – timber, brick, stone, tiles, concrete etc. and their properties. Water supply, drainage and sanitation system.

5. **Farm Power and Machinery:** Agricultural mechanization and its scope. Sources of farm power – animate and electro-mechanical. Thermodynamics, construction and working of internal combustion engines. Fuel, ignition, lubrication, cooling and governing system of IC engines. Different types of tractors and power tillers. Power transmission, ground drive, power take off and control systems. Operation and maintenance of farm machinery for primary and secondary tillage. Traction theory. Sowing transplanting and interculture implements and tools. Plant protection equipment – spraying and dusting. Harvesting, threshing and combining equipment. Machinery for earth moving and land development – methods and cost estimation. Ergonomics of man-machine system. Machinery for horticulture and agro-forestry, feeds and forages. Haulage of agricultural and forest produce.

6. **Agro-energy:** Energy requirements of agricultural operations and agro-processing. Selection, installation, safety and maintenance of electric motors for agricultural applications. Solar (thermal and photovoltaic), wind and bio-gas energy and their utilization in agriculture. Gasification of biomass for running IC engines and for electric power generation. Energy efficient cooking stoves and alternate cooking fuels. Distribution of electricity for agricultural and agro-industrial applications.

7. **Agricultural Process Engineering:** Post harvest technology of crops and its scope. Engineering properties of agricultural produces and by-products. Unit operations – clearning grading, size reduction, densification, concentration, drying/dehydration, evaporation, filtration, freezing and packaging of agricultural produces and by-products. Material handling equipment – belt and screw conveyors, bucket elevators, their capacity and power requirement. Processing of milk and dairy products – homogenization, cream separation, pasteurization, sterilization, spray and roller drying, butter making, ice cream, cheese and shrikhand manufacture. Waste and byproduct utilization – rice husk, rice bran, sugarcane bagasse, plant residues and coir pith.

8. **Instrumentation and computer applications in Agricultural Engineering:** Electronic devices and their characteristics – rectifiers, amplifiers, oscillators, multivibrators. Digital circuits

— sequential and combinational system. Application of microprocessors in data acquisition and control of oscillators, multivibrators. Digital circuits — sequential and combinational system. Application of microprocessors in data acquisition and control of agricultural engineering processes- measurement systems for level, flow, strain, force, torque, power, pressure, vacuum and temperature. Computers — introduction, input/output devices, central processing unit, memory devices, operating systems, processors, keyboards and printers. Algorithms, flowchart specification, programme translation and problem analysis in Agricultural Engineering. Multimedia and Audio-Visual aids.

# B. CIVIL ENGINEERING

## 1. BUILDING MATERIALS

**Timber:** Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.
**Bricks:** Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.
**Cement:** Compounds of, different types, setting times, strength.
**Cement Mortar:** Ingredients, proportions, water demand, mortars for plastering and masonry.
**Concrete:** Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods.

## 2. SOLID MECHANICS

Elastic constants, stress, plane stress, Mohr's circle of stress, strains, plane strain, Mohr's circle of strain, combined stress; Elastic theories of failure; Simple bending, shear; Torsion of circular and rectangular sections and simple members.

## 3. STRUCTURAL ANALYSIS

Analysis of determinate structures – different methods including graphical methods.
Analysis of indeterminate skeletal frames – moment distribution, slope-deflection, stiffness and force methods, energy methods, Muller-Breslau principle and application.
Plastic analysis of indeterminate beams and simple frames – shape factors.

## 4. DESIGN OF STEEL STRUCTURES

Principles of working stress method. Design of connections, simple members, Built-up sections and frames, Design of Industrial roofs. Principles of ultimate load design. Design of simple members and frames.

## 5. DESIGN OF CONCRETE AND MASONRY STRUCTURES

Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Working stress method of design of R.C. members.
Principles of prestressed concrete design, materials, methods of prestressing, losses. Design of simple members and determinate structures. Introductions to prestressing of indeterminate structures.
Design of brick masonry as per I.S. Codes.

## 6. CONSTRUCTION PRACTICE, PLANNING AND MANAGEMENT

**Concreting Equipment:** Weight Batcher, Mixer, vibrator, batching plant, concrete pump, Cranes, hoists, lifting equipment.
**Earthwork Equipment:** Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps.

**Construction, Planning and Management:** Bar chart, linked bar chart, work-break down structures, Activity – on – arrow diagrams. Critical path, probabilistic activity durations; Event based networks.

**PERT Network:** Time-cost study, crashing; Resource allocation.

**7. (a) FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW:**

Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Drag, Lift; dimensional Analysis, Modelling; Cavitation; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows, Measurements; Siphons; Surges and Water hammer; Delivery of Power Pipe networks.

**(b) HYDRAULIC MACHINES AND HYDROPOWER:**

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps, air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

**8. (a) HYDROLOGY:** Hydrological cycle, precipitation and related data analyses, PMP, unit and synthetic hydrographs; Evaporation and transpiration; Floods and their management, PMF; Streams and their gauging; River morphology; Routing of floods; Capacity of Reservoirs.

**(b) WATER RESOURCES ENGINEERING:** Water resources of the globe: Multipurpose uses of Water: Soil-Plant-Water relationships, irrigation systems, water demand assessment; Storages and their yields, ground water yield and well hydraulics; Waterlogging, drainage design; Irrigation revenue; Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals; Sediment transport in canals; Non-Overflow and overflow sections of gravity dams and their design, Energy dissipators and tailwater rating; Design of headworks, distribution works, falls, cross-drainage works, outlets; River training.

**9. ENVIRONMENTAL ENGINEERING**

**(a) WATER SUPPLY ENGINEERING:** Sources of supply, yields, design of intakes and conductors; Estimation of demand; Water quality standards; Control of Water-borne diseases; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance and distribution systems of treated water, leakages and control; Rural water supply; Institutional and industrial water supply.

**(b) WASTE WATER ENGINEERING:** Urban rain water disposal; Systems of sewage collection and disposal; Design of sewers and sewerage systems; pumping; Characteristics of sewage and its treatment, Disposal of products of sewage treatment, streamflow rejuvenation Institutional and industrial sewage management; Plumbing Systems; Rural and semi-urban sanitation.

(c) **SOLID WASTE MANAGEMENT:** Sources, classification, collection and disposal; Design and Management of landfills.

(d) **AIR AND NOISE POLLUTION AND ECOLOGY:** Sources and effects of air pollution, monitoring of air pollution; Noise pollution and standards; Ecological chain and balance, Environmental assessment.

**10. (a) SOIL MECHANICS:** Properties of soils, classification and interrelationship; Compaction behavior, methods of compaction and their choice; Permeability and seepage, flow nets, Inverted filters; Compressibility and consolidation; Shearing resistance, stresses and failure; soil testing in laboratory and in-situ; Stress path and applications; Earth pressure theories, stress distribution in soil; soil exploration, samplers, load tests, penetration tests.

**(b) FOUNDATION ENGINEERING:** Types of foundations, Selection criteria, bearing capacity, settlement, laboratory and field tests; Types of piles and their design and layout, Foundations on expansive soils, swelling and its prevention, foundation on swelling soils.

**11. (a) SURVEYING:** Classification of surveys, scales, accuracy; Measurement of distances – direct and indirect methods; optical and electronic devices; Measurement of directions, prismatic compass, local attraction; Theodolites – types; Measurement of elevations – Spirit and trigonometric levelling; Relief representation; Contours; Digital elevation modelling concept; Establishment of control by triangulations and traversing – measurements and adjustment of observations, computation of coordinates; Field astronomy, Concept of global positioning system; Map preparation by plane tabling and by photogrammetry; Remote sensing concepts, map substitutes.

**(b) TRANSPORTATION ENGINEERING:** Planning of highway systems, alignment and geometric design, horizontal and vertical curves, grade separation; Materials and construction methods for different surfaces and maintenance: Principles of pavement design; Drainage. Traffic surveys, Intersections, signaling: Mass transit systems, accessibility, networking.

# C. WATER RESOURCE ENGINEERING

## 1. IRRIGATION AND DRAINAGE

Irrigation - definition, necessity, advantages and disadvantages; Types of irrigation: surface (flow and lift) and sub-surface (natural and artificial); Water requirement of crops - crop period or base period, duty and delta, relation between duty and delta, importance of duty, factors affecting duty, kor-water demand (kor-watering and kor-period); Consumptive use of water, direct measurement and empirical methods for consumptive use; Application of irrigation water - surface and sub-surface methods, design of sprinkler and drip irrigation; Irrigation efficiencies-application, conveyance, use, storage and distribution; Soil water and plant relationship, soil structure, soil texture, water-holding capacity of soil, classification of soil water, soil water characteristics-field capacity and permanent wilting point; Causes of waterlogging, drainage methods, types of drainage systems, design of surface and subsurface drainage system, land reclamation methods.

## 2. SOIL & WATER CONSERVATION

Soil Erosion - Factors affecting and damages caused, Processes and types of erosion.
Soil Erosion Control Practices - Agronomical practices, Contouring, Crop rotation, Strip cropping, Vegetative control of gullies, Vegetated water ways, Mulching, Green manuring pastures and Agro-forestry.
Contour and Graded Bunds - Types, Layout, Design construction, Cost estimation and maintenance.
Bench Terraces - Types, Design construction, Layout, Cost estimation and maintenance, Land clearing, Leveling and grading.
Gully Control Structures - Types of temporary & permanent gully control structures, Planning and design of soil bed earthen bunds, Wooden post and woven wire check dam, Loose rock fill dam, Drop spillway, Chute and drop inlet spillway.
Land Slides & Erosion Control on Hills - Stream bank erosion, Planning, Design & construction of vegetative & machinery spur, wind erosion and its control practices.
Rain Water Harvesting & Storage Structures - Water harvesting techniques, Types of water harvesting structures, Planning, design & maintenance of ponds and reservoir.

## 3. RESERVOIR PLANNING AND DAM ENGINEERING

Reservoirs planning, Types of Reservoirs, Investigation for reservoirs planning, Site selection and design of reservoir, Economic of reservoir, Classification of dams, Advantages and disadvantages of different types of dams site selection and investigation of dams. Forces acting on gravity dam, rock fill dam and earth dam, causes of failure and stability analysis in gravity dams, foundation requirement in rockfill and earth dam, causes and failure of earth and rockfill and earth dam, seepage analysis, slope stability analysis, seepage control measure, drainage and filters of earth dam. Types of spill ways, outlets. Design of diversion headworks.

## 4. PLANNING & DESIGN OF CANAL NETWORK

Planning, Layout and distribution system of canal network, Types of canals, Canal alignment, Estimation of head discharge and water requirement, Estimation of losses in the canal, Function

of canal regulator, Development, classification of falls, Types of canal outlets, Types of canal lining, Maintenance of lined and unlined canals. Design of lined and unlined canals and channels.

## 5. HYDROLOGY

Weather and hydrology, Hydrologic Cycle, Precipitation – Forms, measurements and estimations; Evaporation & transpiration - Factor affecting, measurements and estimation; Stream flow measurement - Measurement of stage & velocity, Stage discharge relationship; Runoff - Introduction hydrograph, runoff characteristics of streams, yield (annual runoff volume), flow duration curve, flow mass curve. Hydrograph - Factors affecting flood hydrograph, Components of hydrograph, Base flow separation, Effecting rainfall, Unit hydrograph.

## 6. RIVER ENGINEERING & FLOOD WATER CONTROL

**River Engineering:**Introduction and classification of river, behavior of rivers, river region theory, mechanism of meanders development, types of alluvial river region, cut off, effects of dam on river region.

**Objectives and Principles of River Training:** Methods of river training, classification of river training works, design parameters of embankments, bank protection spurs and artificial cutoff.

**Flood Control:** Definition and causes of floods, Different methods of flood control, selection and estimation of design flood, CWC recommendations to select design flood for various hydraulic structures. Flood control by reservoirs, operation problems of flood control reservoirs, Levees and flood walls, diversion of flood water, watershed management for flood control, flood plain management, emergency evacuation, flood-plain zoning and flood proofing, benefit of flood control.

## 7. GROUND WATER DEVELOPMENT

Occurrence, Distribution & Movement of ground water supply; Geologic formation of ground water supply; Methods of Ground water exploration; Types of Aquifers and Wells; Aquifer Properties – Hydrologic properties of aquifers; Steady and Unsteady Flow in a confined and unconfined aquifer; Types of Wells - Open Wells and Tube Wells and their Construction; Development of Wells; Ground Water Recharge; Methods of Ground Water Recharge; Development of Ground Water – Zones of Under Ground Water, Movement of Ground Water and its Velocity, Darcy's Law for determining Ground Water, Empirical Formulas for estimating Ground Water Velocity.

## 8. WATER SUPPLY & WASTE WATER ENGINEERING

**Water Supply Engineering:**Planning of Urban Water Supply Projects & its implementation. Communicable diseases, rodents and vector control. Urban sanitation including refuge disposal. Waste treatment within Municipal authority. Planning of Rural water supply system, water quality and quantity requirements. Design criteria for water supply system, Transmission and distribution systems, storage facilities.

**Waste Water Engineering:** Wastewater characteristics: physical, chemical and biological. Wastewater treatment: treatment processes & design including activated sludge process and trickling filter.

## 9. REMOTE SENSING AND GIS

Introduction to remote sensing, Energy sources and Radiation principles, Energy equation, EMR and Spectrum, EMR interaction with Atmosphere scattering, Absorption, EMR interaction with earth surface features reflection, absorption, emission and transmission, Spectral response pattern, vegetation, soil, water bodies - Spectral reflectance, elements of visual image interpretation, interpretation keys, advantages and disadvantages of remote sensing. Definition of GIS and Components of GIS. Types of Remote Sensing – classification based on platforms, energy source, imaging media, electromagnetic spectrum and number of bands; Sensor Resolutions: spatial, spectral, radiometric and temporal resolution. Applications of Remote Sensing & GIS in water resources.