Nepal Engineering Council Registration Examination

Hydropower Engineering Syllabus (AHyE)

Chapters 1-5 are fundamentals/principles a concept of civil engineering; chapters 5-9 are related to application and core of hydropower engineering principles in practice; and the last (10th) chapter is related to project planning, design and implementation.

1. Basic Civil Engineering (ACiE01)

1.1 Engineering materials: Properties (physical, chemical, mechanical and thermal); types, characteristics, composition, selection, and usage/function of engineering materials (stones, bricks, tiles, cement, lime, timber, metals/alloys, paints/varnishes, and asphalt/bitumen/tar). (ACiE0101)

1.2 Standards (NS & IS) and tests for civil engineering materials: tests of brick (water absorption and compressive tests), tests of cement (consistency, setting time, soundness, and compressive strength); test of aggregate (bulking of sand); test of rebar (tensile test). (ACiE0102)

1.3 Building technology: Building construction technology (brick and stone masonry, carpentry, painting, plastering, concrete roofing, flooring, damp proof course); Building by laws. (ACiE0103)

1.4 Geometric properties of sections: Axes of symmetry; centre of gravity of different sections (e.g., built-up plane figures, standard steel sections); moment of inertia; radius of gyration (ACiE0104)

1.5 Surveying and levelling: Fundamentals of surveying; measurements (linear distance, vertical distance, and angle and directions); levelling; topographic survey (principles and applications); Simple circular curves, principles and applications of GPS/GIS. (ACiE0105)

1.6 Estimating, costing, and valuation: types of estimate; methods of estimating; rate analysis; specifications (purpose, importance and types), valuation. (ACiE0106)

2. Soil Mechanics and Foundation Engineering (ACiE02)

2.1 Soil properties and laboratory tests: tests for strength, permeability, compressibility, phase relationships; determination of index and engineering properties of soils; soil classification (descriptive, textural, ISI, MIT, USCS); boring log interpretation; sieve analysis and interpretation of results; determination of Atterberg limits of soils. (ACiE0201)

2.2 Stresses on soil and seepage: effective stress (factors affecting effective stress, capillary rise, and quick sand conditions); seepage analysis [Seepage pressure, flow nets and their applications]; soil compressibility (including various indices) and compaction (definition, affecting factors). (ACiE0202)

2.3 Shear strength of soil and stability of slopes: Concept of shear strength, principal planes and principal stresses; Mohr-Coulomb theory of shear strength; calculation of normal and shear stresses at different planes; relation of principle stress at failure condition; types of shear tests; stability of slopes. (ACiE0203)

2.4 Soil exploration, earth pressure and retaining structures: soil exploration (methods, planning, soil sampling and samplers, field tests, site investigation reports); earth pressure theories; stability analysis of retaining walls; techniques to increase stability of retaining walls. (ACiE0204)

2.5 Fundamentals of foundation: Definition, Types (Shallow and Deep), functions, factor affecting, site investigation of foundation, concept of spread and mat foundation. (ACiE0205)

2.6 Bearing capacity and foundation settlements: bearing capacity (types, effects of various factors); modes of foundation failure; Terzaghi's general bearing capacity theory; ultimate bearing capacity of cohesion-less and cohesive soils; consolidation (concept, types and tests); settlement (types, nature, effects and calculations). (ACiE0206)

3. Basic Water Resources Engineering **(ACiE03)**

3.1 Fluids and their properties: types of fluids; fluid properties (mass density, specific weight, specific gravity, specific volume, viscosity, compressibility, capillarity, surface tension, cavitation and vapour pressure. (ACiE0301)

3.2 Hydrostatics: pressure and head; Pascal's law; pressure-depth relationship; manometers; pressure force and centre of pressure on submerged bodies (plane and curved surfaces, practical applications); pressure diagrams; buoyancy; stability of floating/submerged bodies, relative equilibrium. ACiE0302)

3.3 Hydro-kinematics and hydro-dynamics: classification of fluid flow; conservation of mass (continuity equation) and momentum equations and their applications; Bernoulli's equation and its application; flow measurement. (ACiE0303)

3.4 Pipe flow: types, governing equations, major and minor head losses; HGL and TEL lines; design; pipe network problems; unsteady flow in pipes and relief devices. (ACiE0304)

3.5 Open channel flow: geometrical properties; various types of flows; energy and momentum principles (Specific Energy and Specific Force); Types of gradually varied flow profiles; hydraulic jump (types, theory for horizontal and rectangular) flow in mobile boundary channel (design principles/approaches; inception motion condition; Shield diagram). (ACiE0305)

3.6 Hydrology: hydrologic cycle and water balance components; flow measurement and rating curves; hydrographs analysis and synthetic unit hydrographs; rainfall-runoff analysis; flood hydrology (flood frequency analysis and design flood); groundwater hydrology. (ACiE0306)

4. Structural Mechanics **(ACiE04)**

4.1 Shear forces and bending moments: Axial forces, shear forces, and bending moments; loads and load superposition; relationship and diagram Interpretation (AF, SF, BM). (ACiE0401)

4.2 Stress and strain analysis: normal and shear stresses; principal stresses and principal planes; maximum shear stress and corresponding plane; stress-strain curves; torsion (ACiE0402)

4.3 Theory of flexure and columns: co-planar and pure bending; elastic curve; angle of rotation; radius of curvature and flexural stiffness; deflection; bending stress; Euler's formula for long column. (ACiE0403)

4.4 Determinate structures-1: Degree of determinacy, Energy Methods, Virtual Work Method, Deflection of beams and portal frame. (ACiE0404)

4.5 Determinate structures-2: Influence Lines for Simple Structures with point loads and UDL; analysis of two hinged arches. (ACiE0405)

4.6 Indeterminate structures: Flexibility Method, Two-Hinged Parabolic Arches, Slope Deflection Method, Moment Distribution Method, Stiffness method, Influence Lines for Continuous Beams, Elementary Plastic analysis. (ACiE0406)

5. Design of Structures **(ACiE05)**

5.1 Loads and load combinations: Dead Load, Imposed Load, Wind Load, Snow Load, Earthquake Load. (ACiE0501)

5.2 Concrete technology: concrete technology (materials, properties, mix design, testing, quality control, and codes (IS and NS)). (ACiE0502)

5.3 RCC structures-1: working stress and limit state methods; design of beams and slabs; analysis of RC beams and slabs in bending, shear, deflection, bond and end anchorage; RCC; NS & IS codes. (ACiE0503)

5.4 RCC structures-2: design of columns and isolated/combined footings; pre-stressed concrete; NS & IS codes. (ACiE0504)

5.5 Steel structures: standard and built-up sections; design of bolted and welded connections; design of simple elements such as ties, struts, axially loaded columns, and column bases; NS and IS codes. (ACiE0505)

5.6 Timber and masonry structures: design principles of timber beams and columns; Design of masonry structures (Mandatory rules of thumb, Nepal Building Code (NBC), properties), Failure modes of masonry structure, mud mortar, lime mortar and cement mortar and its properties. (ACiE0506)

6. Fundamental of Hydropower Engineering (AHyE06)

6.1 Planning of hydropower projects: power potential (gross, technical, economic) of Nepal and the world; hydropower development in Nepal (history, recent policy, recent acts and regulations);licensing provision in Nepal, hydropower related stakeholders; types of hydropower plants on various basis; stages of hydropower development and study related to them; various types of hydropower projects and its suitability (ROR, PROR, Storage etc.); Concept of hydropower installation and operation. (AHyE0601)

6.2 Power potential and sediment study: processing of hydrological data; estimation of gross and net heads, and power and energy potentials; methods of fixing installed capacity of a plant; load analysis to the system; power market study. Load curve; capacity, utilization and diversity factor; power variation (daily, weekly, monthly and annual variation of power); power grid and its component; Reservoir regulation, Source of Sediments, types, sediment sampling and analysis. (AHyE0602)

6.3 Headworks of storage plants: components of a typical storage plant; dams (types, functions, selection, design, failure modes and remedies); stability analysis of gravity dam, seepage control and foundation treatment in dams; design of intake, spillway and energy dissipaters; gates (types and locations). (ACiE0803)

6.4 Headworks of run-of-river (ROR) plants: components of a typical ROR plant; design of intake; methods of bed and suspended load handling; design of settling basin (practice and concentration approach), estimation of sediment volume in settling basin, flushing of deposited sediment, estimation of flushing frequency for sediments. (ACiE0804)

6.5 Water conveyance structures: hydraulic tunnels, x-sections, and hydraulic design (velocity and sizing); concept of tunnel stability and protection measures; tunnel lining; design of forebay and surge tanks; design of penstocks and pressure shaft; hydraulic transients (water hammer) and hydro-dynamic pressure calculations. (ACiE0805)

6.6 Operation and regulation of hydropower projects: Concept of hydropower installation and operation; initial test of hydropower production and its importance; erection, acceptance and commissioning of works; hydropower production, regulations, and role of government institutions involved in power sector development; transmission works; power regulation and optimization of hydropower projects; Load curve and capacity; utilization and diversity factor; power variation (daily, weekly, monthly and annual variation of power); power grid and its component; Optimization (e.g., dam height, reservoir capacity, installed capacity, multipurpose projects, etc.). (AHyE0606)

7. Electro-Mechanical Equipment in Hydropower (AHyE07)

7.1 DC generators: Types of dc generator, characteristics and EMF equations, generator performance curve, causes of failure to build up voltage, voltage regulation and efficiency; Parallel operation of DC generators. (AHyE0701)

7.2 Three-phase synchronous generator: Construction details, rotor types, excitation systems; working principle, Emf equation, Armature reaction and its effects; Principle of operation, starting methods, No load and load operation, Effect of excitation and power factor control; Parallel operation of alternators; Synchronization condition and requirement; Load sharing by parallel units). (AHyE0702)

7.3 Three-phase induction motors and generators: Principle of operation, construction, , torque developed in an induction motortorque-speed characteristics, starting & speed control; Three phase induction generators(working principle, voltage build up process) (AHyE0703)

7.4 Basic introduction and transfer of energy in pumps and turbines: Unit quantities, head, specific speed, power, efficiency, Classification of pumps and turbines, Operating principles and component in pumps and turbines, Structures of pumps and turbines, Dimensional analysis and similarity; Fluid flow through pumps and turbines; Velocity vector diagrams; Conservation of Momentum; Euler equation for pumps and turbines; Effect of impeller vane angle, guide vane and runner blades angles. (AHyE0704)

7.5 Basic design of turbines: Pelton, Francis and Kaplan turbines, turbine characteristics curve, Selection of appropriate hydro turbine (AHyE0705)

7.6 Performance, cavitation and erosion of pumps and turbines: Performance curves, Energy losses of pumps and turbines; System characteristics, Operating point for different pumps system; Pumps in parallel and in series; Definition, Causes, effects and prevention of cavitation, cavitation index; Sediment erosion in hydro-turbines in Nepal; Effect of sand erosion on pumps and turbine components and its consequences; Prevention techniques and methods of hydro-turbines by erosion. (AHyE0706)

8. Power System Apparatus, Geographical Information System, and Remote Sensing (AHyE08)

8.1 Measurement of electrical quantities and control of hydro generating system: Electrical Measurement Devices; (Wattmeter-types (Energy, Frequency, and Power factor) and working principles); Instrument transformers (CT and PT); Auto transformer; Busbar arrangement; P-f and Q-V control loop of hydro generating system; different types of speed-governors. (AHyE0801)

8.2 Power system protection: Protection components and protection; Fuse (element, current, fusing factors, pre arcing, arcing time, Types (Construction, operating characteristic, application and merits and demerits)); Isolators and Contactors (construction, operation, type, and application); Circuit breakers (Breaking process, Construction, operating principle and application of various types of circuit breakers, Circuit breaker ratings and Testing); Protective relays (Introduction, classification, Method of earth fault detection, and Types) (AHyE0802)

8.3 Earthing system and substation equipment: Over voltage protection (Overhead earth wire, , horn gap and rod gap lightning arrestor, surge absorbers); Earthing (Definition, purpose, methods, measurement of soil resistivity, and design); Firefighting system in power station; Power Line Carrier Communication; PLC Application; Supervisory Control and Data Acquisition (SCADA) System. (AHyE0803)

8.4 Basics of GIS application: History, need, Components, Functions, and application of GIS; Vector representation; Different types of data; Data processing steps; Raster data and vector data model; concept of Geocoding; Attribute data; Editing and validation; Coordinate system; Map projection; Accuracy and precision. (AHyE0804)

8.5 Data base management and spatial analysis: Databases concepts and components; Database processing and management systems; Data dictionary; Spatial interpolation methods; Raster methods including topological overlays; DEM (Digital Elevation Model). (AHyE0805)

8.6 River network analysis and remote sensing: Watershed boundary Delineation (Flow direction; flow accumulation; river network; and boundary delineation); ; Basic concept of remote sensing; ; Introduction to different satellites; Resolutions in remote sensing; Application of remote sensing. (AHyE0806)

9. Road and Tunnel Engineering (AHyE09)

9.1 Highway planning and survey: Modes of transport, history of road development in Nepal; classification of roads; road survey; highway alignment and controlling factors; evaluating alternate alignments; Road Standards of Nepal. (ACiE0901)

9.2 Geometric design of highway: basic design control and criteria; elements of highway cross-section; highway curves; super elevation; average and ruling gradients; stopping sight distance; design considerations for horizontal and vertical alignments, extra widening, and set back distance; design of road drainage structures; design considerations for hill roads. (ACiE0902)

9.3 Highway materials: types of aggregates and tests on their gradation, strength, durability; binding materials and their tests; design of asphalt mixes; evaluation of subgrade soil. (ACiE0903)

9.4 Road pavement: different types of pavement; design methods for flexible and rigid pavements (DOR Guidelines); loads and other factors controlling pavement design; stress due to load, temperature. (ACiE0905)

9.5 Road construction technology: activities, techniques, tools, equipment and plants used in road construction; preparation of road subgrade, soil moisture density relationship; field compaction control and soil stabilization; construction of asphalt concrete layers; construction procedure for penetration macadam, bituminous bound macadam and plain cement concrete pavements; road maintenance, repair and rehabilitation. (ACiE0906)

9.6 Road and tunnel-related hazards: Hazard, vulnerability, risk; geo-hazards (mass movement, landslide, debris flow); earthquake hazards; rock mass classification; rock slope stability analysis; stress and stability analysis in a tunnel section; (AHyE0906)

10. Project Planning, Design and Implementation (AALL10)

10.1 Engineering drawings and its concepts: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, orthographic projection, isometric projection/view, pictorial views, and sectional drawing. (AALL1001)

10.2 Engineering Economics: understanding of project cash flow; discount rate, interest and time value of money; basic methodologies for engineering economics analysis (Discounted Payback Period, NPV, IRR & MARR); comparison of alternatives, depreciation system and taxation system in Nepal. (AALL1002)

10.3 Project planning and scheduling: project classifications; project life cycle phases; project planning process; project scheduling (bar chart, CPM, PERT); resources levelling and smoothing; monitoring/evaluation/controlling. (AALL1003)

10.4 Project management: Information system; project risk analysis and management; project financing, tender and its process, and contract management. (AALL1004)

10.5 Engineering professional practice: Environment and society; professional ethics; regulatory environment; contemporary issues/problems in engineering; occupational health and safety; roles/responsibilities of Nepal Engineers Association (NEA). (AALL1005)

10.6 Engineering Regulatory Body: Nepal Engineering Council (Acts & Regulations). (AALL1006)