द्वितीयपत्र (Paper II) : Technical Subject

Section (A) - 30 Marks

1. **Structural Engineering**

1.1 Reinforced concrete structures: difference between working stress and limit state philosophy, design of beam and slab, analysis of RC beams and slabs in bending, shear, deflection, bond and end anchorage, design of axially loaded columns; isolated and combined footings, introduction to pre-stressed concrete

1.2 Steel and timber structures: standard and built-up sections: design of riveted, bolted and welded connections, design of simple elements such as ties, struts, axially loaded and eccentric columns, column bases, design principles of timber beams and columns

1.3 Requirements of earthquake resistant building construction

1.4 Mandatory rule of thumb in building design

1.5 Structural design of bridge: various types of bridges, selection and type of bridges and economic span length, types of loads, forces and stresses, live load, impact load, wind load, longitudinal forces, lateral loads, centrifugal force, width of roadway and footway, general design requirements, solid slab bridges, deck girder bridges, B.M. in slab supported on four edges, distribution of live loads on longitudinal beams, method of distribution coefficients, Courbon's method, design of a T- beam bridge, balanced cantilever bridge, design of box culvert, Pre-stressed bridges, types of bridge foundation

2. **Geotechnical Engineering**

2.1 **Soil Mechanics**

2.1.1 **Identification and classification of soils**

Field identification of soils and soil classification: descriptive, textural, ISI, MIT and USCS

2.1.2 **Permeability of soils**

Factors affecting permeability of soil, determination of coefficient of permeability: laboratory and field methods

2.1.3 **Effective stress**

Factors affecting effective stress, capillary rise, quick sand condition

2.1.4 **Seepage analysis**

Flow net, application of flow net, seepage below concrete dam, sheet pile and safety check, seepage analysis through earthen dam and filter layer design, techniques to reduce discharge and to increase safety of dam

2.1.5 **Compaction of soil**

Concept of compaction, lab test, factors affecting compaction, specification of compaction, field control of compaction, methods of compaction in field and their suitability, special parameters to be considered for compaction in road, earthen dam

2.1.6 **Shear strength of soils**

Concept of shear strength, principal planes and principal stresses, Mohr-Coulomb theory of shear strength, calculation of normal stress and shear Stress at different plane, relation of principle stress at failure condition, types of shear tests: direct shear test, unconfined compression test, triaxial test, vane shear test

2.1.7 **Consolidation and settlements**

Concept of consolidation, types of consolidation, test of consolidation, NC, OC, OCR, preconsolidation pressure, calculation of settlement, settlement of structures resting on soil: its nature, causes and remedial measures

2.1.8 **Stability of slopes**

Causes of slope failures, types of slope and slope failures, critical surfaces and factor of safety, method of stability analysis and stability number, bio-engineering: advantages, principles, concept, components and uses in stabilization of slope

2.2 **Foundation Engineering**

2.2.1 **Introduction**

Types of foundation, factors affecting on selection of foundation, requirement and criteria of ideal foundation, types of load for design of foundation, criteria for selection of depth of foundation

2.2.2 **Earth pressure and retaining structures**

Rankine's earth pressure theory, Coloumb's earth pressure theory, trial wedge theory, types of earth pressure, types of retaining wall, stability analysis of earth retaining structures, techniques to increase stability of retaining wall

2.2.3 **Bearing capacity and settlements**

Types of bearing capacity and factors influencing bearing capacity, effects of various factors on bearing capacity, modes of foundation failure, Terzaghi's general bearing capacity theory, ultimate bearing capacity of cohesionless and cohesive soils, settlement: types, nature and effects

2.2.4 **Types of foundation and their suitability in context of Nepal**

Open foundation: condition to use spread or strap or combined footing; mat: types, bearing capacity, construction approach, floating mat, compensating mat; pile: types, load carrying capacity, negative skin friction (NSF) and calculation; caisson: types, bearing capacity, construction of well, tilt and shift of well and its retrofication and prevention, suitability of different types of foundation

2.2.5 **Design of foundation**

Design of spread footing foundation, combined footing, strap footing, mat foundation, pile foundation, well foundation

2.2.6 **Foundation stabilization**

Soil stabiliazation, stone column, sand pile, dynamic deep compaction, grouting and its methods, methods of underpinning, methods of dewatering

2.3 **Site Investigation and Soil Exploration**

2.3.1 Purpose of site investigation, planning of investigation, stages of investigation, methods of boring, types of soil samples

2.3.2 In-situ test: standard penetration test, dynamic cone penetration test, correction of N value, calculation of bearing capacity using N value for isolated footing, mat, pile and well, plate load test, pile load test

2.3.3 Preparation of site investigation report

Section (B) - 25 Marks

3. **Water Resource Engineering**

3.1 **Hydrology and Sediment**

3.1.1 Rainfall measurements and related analysis

3.1.2 Flow measurements, rating curve and generation of flow data

3.1.3 Estimation of long term daily and monthly flows, low flows

3.1.4 Hydrograph analysis, synthetic unit hydrographs

3.1.5 Flood frequency analysis, estimation of design flood

3.1.6 Collection of sediment data, sediment rating curve, estimation of sediment yield and concentration, reservoir sedimentation

3.1.7 Ground water hydrology

3.2 **Hydraulics**

3.2.1 Fluid pressure, fluid kinematics, dynamics of flows

3.2.2 Boundary layers, uniform flow, steady flow, laminar and turbulent flow

3.2.3 Bernoulli's equation and its applications

3.2.4 Laminar and turbulent flow in pipes

3.2.5 Concept of specific energy and gradually varied flows in open channel

3.2.6 Hydraulic jump and its types, flow profiles

3.3 **Irrigation**

3.3.1 Function, advantages and disadvantages of irrigation; status and need of irrigation in Nepal

3.3.2 Crops and soils, crop water and irrigation water requirements, water availability for irrigation

3.3.3 Irrigation methods (surface, sub-surface, sprinkler and drip), their suitability, advantages and disadvantages

3.3.4 Canal types, network and alignment, canal losses, commad area, duty and delta

3.3.5 Silt theories, design of earthen and lined canals, canal standards, specific considerations for hill irrigation

3.3.6 Design of irrigation structures on permeable foundation (seepage theories, piping & uplift)
3.3.7 Design of weir and barrage (crest, length and thickness of impervious floor)
3.3.8 Design of silt control structures (excluder, ejector and settling basin)
3.3.9 Design of energy dissipators (hydraulic jump and stilling basins)
3.3.10 Types and design of river training works
3.3.11 Design of regulators, drops, cross-drainage and outlets
3.3.12 Waterlogging (causes, effects and measures), design of surface and subsurface drainage, watershed management
3.3.13 Planning and Management of Irrigation System, major farmer managed irrigation system within the province

3.4 **Hydropower**

3.4.1 Hydropower development in Nepal, policy, acts and regulations
3.4.2 Types of hydropower projects (run-off river, storage, and pump storage)
3.4.3 Flow duration curve, determination of reservoir capacity, reservoir sedimenataion, useful life of reservoir
3.4.4 Power demand analysis and forecast
3.4.5 Potential and firm power, maximum power output, firm energy, surplus energy, seasonal energy, and average annual energy
3.4.6 Concept of load, load curve, capacity factor, load factor, and utilization factor
3.4.7 Power demand variation (daily, weekly, monthly, seasonal, and annual)
3.4.8 Layout of reservoir, diversion structures, de-sanding basin, water conveyance system, fore-bay, surge tank, penstock, power house, draft tube, tailrace, switch yard and auxiliary structures
3.4.9 Dam classification and their usage based on functionality, acting forces, and construction material; selection of dam based on construction material, topography, economy and purpose
3.4.10 Concrete gravity dams: forces on gravity dams, their line of actions, stability against sliding, overturning and floating
3.4.11 Embankment dams: earth and rock-fill dams; basic design principles, concept of seepage through embankments, considerations in foundation and slope stability
3.4.12 Concept of coffer-dam and their usage
3.4.13 Design of spillways, types of spillway gates, location, and their functions
3.4.14 Energy dissipation methods, types of energy dissipators, design of stilling basin and aprons
3.4.15 Design of intake, trash rack, gravel trap and approach canal
3.4.16 Types, location and usage of de-sanding basin, suspended sediment characteristics, sediment velocities to be considered in de-sanding basin design, design of de-sanding basin, flushing of sediments from de-sanding basin

3.4.17 Hydraulic tunnels: pressure and non-pressure tunnels, tunnel cross-section and size, head loss in tunnels, concept of tunnel stability and protection measures, tunnel linings

3.4.18 Water hammer, hydrodynamic pressure calculations, design of fore-bay basin

3.4.19 Importance, location and application of penstock, anchor blocks and saddle support

3.4.20 Underground and surface power houses, power house dimensions and design

3.4.21 Types and selection of turbines, concept of specific speed, gates and valves, draft tube, need and working principle of governors

Section (C) - 25 Marks

4. **Transportation Engineering**

4.1 **Highway engineering**

4.1.1 **Highway Planning and Survey**

Approach to road planning: establishing economic and environmental viability, evaluating alternatives, historical development of road construction in Nepal, classification of roads, national road network of Nepal , road survey and quantity calculation, process of identifying best route location, map study and reconnaissance survey, preliminary and detail survey, recommendation for best alignment, highway alignment and controlling factors, Asian Highway in Nepal, NRS 2070 and NRRS 2071

4.1.2 **Geometric Design of Highway**

Basic design control and criteria: design speed, vehicle charecteristics, traffic volume & its composition, topography, elements of highway cross section, highway curves: type of curves, transition curves, reverse curves and their functions, circular curves, super elevation, stopping sight distance, vertical curves, gradients, average gradients and ruling gradient, Crest curve and sag curves, design considerations of horizontal and vertical alignment, extra widening, set back distance

4.1.3 **Evaluation of subgrade soil**

Function of subgrade soil, CBR ant its test, group index, plate load test, determination of modulus of subgrade reaction (k), dynamic penetration test and its application

4.1.4 **Hill Roads**

Hill road design: speed, sight distance, geological conditions and alignment selection criteria, gradient selection, Hair Pin Bends, horizontal curves, passing lane in hill roads, retaining and slope protection structures in hill roads, use of bio-engineering, drainage structures, stability of formation width and cut and fill slopes

4.1.5 **Highway Drainage**

Importance of highway drainage: surface drainage and estimation of water quantity, design of drainage structures, erosion control and dissipating structures, subsurface drainage, cross drainage structures and types

4.1.6 **Highway Materials**

Types of aggregate and tests on their gradation, strength, durability, mathematical and graphical method of aggregate gradation, binding materials, bitumen, road tar, penetration test, consistency tests, flash point test, composition tests, bituminous mixes and asphalt concrete, open and dense graded mixes, design of asphalt mixes,

4.1.7 **Traffic Engineering**

Traffic engineering and scope, interrelationships between human/ machinery/ environmental elements, impact of human and vehicular characteristics on traffic planning, traffic operations and regulations, driver and vehicle control, traffic control devices, traffic flow counts and speed studies, traffic flow characteristics, traffic count and presentation, O and D studies, parking studies, accident study and analysis, basic requirements of intersections, types of intersections and configuration, channelized and unchannelized intersections, design of intersections, traffic signs, signals, road marking, road delineation, road lighting, factors influencing night visibility, design of the lighting system, traffic projection and forecasting

4.1.8 **Road Pavement**

Elements of road cross section and their function, types of road pavements, flexible and rigid pavement, loads and other factors controlling pavement, design methods for flexible pavements, design methods for rigid pavements, stress due to load, temperature and sub-grade friction, functions of pavement structure, axle load, damaging factor of axle loads, different types of pavement surface

4.1.9 **Road Construction Technology**

Activities and techniques used in road construction, tools, equipment and plants used in road construction, preparation of road subgrade, excavation, filling, compaction, moisture density relationship, field compaction control, soil stabilization, Construction of asphalt concrete layers including prime coat, tack coat, and seal coat, construction procedure of penetration macadam, construction procedure of bituminous bound macadam, construction procedure of plain cement concrete pavements

4.1.10 **Highway Maintenance, Repair and Rehabilitation**

Classification of maintenance activities for on-road and off-road structures, inspection, prioritization and planning of maintenance operations, evaluation of pavement distress and pavement condition, types and methods of

pavement repair, regular, recurrent, periodic mentinance, types of overlay and strengthening of existing pavements

Section (D) - 20 Marks

5. **Public Health Engineering**

5.1 **Water Supply**

5.1.1 **Introduction**

Potable, contaminated and wholesome water, typical components of water supply schemes

5.1.2 **Sources of water**

Surface source, ground water occurrences and prospecting, chemical characteristics and properties of ground water, recharge of ground water, ground water recovery, tube well design, selection of water sources

5.1.3 **Quality of water**

Types and sources of water pollution, effects of pollution (river, lake and reservoir), pollution of ground water, hardness of water, alkalinity in water, living organism in water, water borne diseases, physical, chemical and biological test of water, water quality standard: WHO standard of drinking water quality, National drinking water quality standards, 2005

5.1.4 **Quantity of water**

Types of water demand, design period, methods of population forecasting, variation in demand of water, factors affecting demand of water

5.1.5 **Intake works**

Site selection of an intake, Characteristics of river reservoir and spring intake, various types of hand pumps including suction hand pump, submersible hand pumps

5.1.6 **Water treatment**

Treatment systems: screening, plain sedimentation, sedimentation with coagulation, flocculation, filtration (Slow sand filtration /Rapid filtration), disinfection, softening, and miscellaneous treatments (aeration, removal of iron and manganese, removal of arsenic and removal of colour, odour and taste

5.1.7 **Reservoirs and distribution systems**

Types of reservoirs, sizing of reservoirs: mass curve method, peak demand method etc. for reservoir Design, Water supply system: pumping system, gravity system, Layout of the water supply system, Pipeline design: design criteria, design of transmission and distribution system (including pipe net works)

5.1.8 **Operation and maintenance of water supply system**

Difference beween maintenance and rehabilitation, Operation of water supply system, Maintenance tools and equipments

5.1.9 **Design specific of gravity flow rural water supply system in Nepal**

5.2 **Sanitary Engineering**

5.2.1 **Introduction**

Importance of waste water and solid waste management, Sanitation system, Types of sewerage systems

5.2.2 **Quantity of wastewater**

Sources and nature of wastewater, effluent characteristics, Factors affecting sanitary sewage, Determination of quantity of sanitary sewage, Determination of quantity of storm water

5.2.3 **Characteristics and examination of sewage**

5.2.4 Sampling of sewage, physical, chemical and biological characteristics of sewage, decomposition of sewage, aerobic and anaerobic decomposition, Biochemical Oxidation Demand (BOD) and Chemical Oxidation Demand (COD), test of solids, Dissolved Oxygen (DO), pH-value, BOD, COD, chlorine demand

5.2.5 **Design and construction of sewers**

Typical design periods, flow velocity, self cleaning velocity, flow diagrams, hydraulic formulae and gradients, estimation of quantity of sanitary sewage, collection systems, sewer design criteria, shape of sewers, types of sewers, sewer materials: requirements, salt glazed stoneware and plain or reinforced cement concrete pipes, plastic, steel, brick, sanitary and storm water sewers for separate and combined sewer systems, construction of sewer: excavation, laying, jointing of sewer, testing of sewer, water test and air test

5.2.6 **Sewage treatment**

Treatment methods, Secondary treatment processes and their types, BOD removal, design criteria, activated sludge, oxidation ponds and ditches, aerated lagoons and lagoons, Sewage filtration, intermittent sand filter, contact bed, trickling filters, bio- filters and design of trickling and biofilters

5.2.7 **Sewage disposal**

Sewage disposal by dilution: essential conditions for dilution, self purification of streams, factors affecting self –purification, the oxygen sag curve (streeter-phelps equation), Sewage treatment by land treatment

5.2.8 **Sludge treatment and disposal**

Sources of sludge and necessity of treatment, Aerobic and anaerobic digestion, Methods of sludge treatment: grinding and blending, thickening, stabilization, dewatering, drying, composting and incineration, Methods of sludge disposal: spreading on land, lagooning, dumping and land filling

5.2.9 **Community participation**

Users committee, Village maintenance workers, Pre construction/during construction/post construction trainings, Women participation, Community mobilization/ participation, Record keeping of WSP, Rehabilitation, Composting toilets, eco-sanitation

5.3 **Environmen**t

5.3.1 General introduction of air pollutants, its causes, impacts and remedial measures

5.3.2 Human excreta and its characteristics, pollution caused by excreta

5.3.3 Health aspects of water supply and sanitation

5.3.4 Green house effects, its impacts and remedial measures

5.3.5 Solid waste management,Types and characteristics of solid waste

5.3.6 Garbage collection and disposal

5.3.7 Methods of solid waste disposal: dumping, sanitary landfill, incineration and composting

5.3.8 Concept of environmental assessment: Initial Environmental Examination (IEE), Environment Impact Assessment (EIA), role of EIA, Types of environmental impacts, and EIA principles

5.3.9 Government rules and regulations and procedures for EIA
