

लोक सेवाआयोग

नेपाल इंजिनियरिङ सेवा सिभिल समूह अन्तर्गतका जनरल, हाइवे, हाइड्रोपावर, इरिगेशन, स्यानिटरी र एयरपोर्ट उपसमूहहरुको
राजपत्राङ्कित तृतीय श्रेणीका पदहरुको खुला प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

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

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, Coulomb'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

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; comparison between pile, pier, and caisson; caisson: types, bearing capacity, construction of well, tilt and shift of well and its retrofication and prevention

2.2.5 Design of foundation

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

2.2.6 Foundation stabilization, underpinning and geotechnical process

Soil stabilization, 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

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- 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, command 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 dissipaters (hydraulic jump and stilling basins)
- 3.3.10 Design of river training works (guide bund, levees and spurs), water shed management
- 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

3.3.13 Planning and Management of Irrigation System

3.4 **Hydropower**

3.4.1 Hydropower development in Nepal, policy, acts and regulations

3.4.2 Types of hydropower projects (run-off river, peaking storage, and pump storage)

3.4.3 Flow duration curve, determination of reservoir capacity, reservoir sedimentation, 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, tailrace
- 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 and NRS–2045, NRS 2070

4.1.2 Geometric Design of Highway

Basic design control and criteria: design speed, vehicle characteristics, traffic volume & its composition, topography, elements of highway cross section, highway curves: tangents, 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

Binding 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,

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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 and 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 delination, road lighting, factors influencing night visibility, design of the lighting system, traffic projection and forecasting

4.1.8 **Road Pavement**

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 maintenance, types of overlay and strengthening of existing pavements

4.2 **Airport Engineering**

4.2.1 **Introduction**

4.2.1.1 History of civil aviation in Nepal

4.2.1.2 Role and functions of Ministry of Culture, Tourism and Civil Aviation (MoCTCA) and Civil Aviation Authority of Nepal

4.2.1.3 Role of International Civil Aviation Organization (ICAO)

4.2.1.4 The economic, political, and social roles of airports

4.2.2 Airport Planning

- 4.2.2.1 Planning consideration: Airport and airport systems, airport system planning, airport master plan and strategic plan, information required, preliminary feasibility, role of financing
- 4.2.2.2 Forecasting for planning purpose (Passenger, Aircraft, Cargo, Mail): Inventory and forecasting, factors affecting traffic growth, principles of forecasting, forecasting methods, accuracy and limitations of forecasting
- 4.2.2.3 Airport site evaluation: factors affecting airport location
- 4.2.2.4 Airside development: Physical characteristics runway, taxiway & apron, airport capacity and delay.
- 4.2.2.5 Landside development: Passenger terminal building and Terminal System, Design Considerations, apron-gate system, passenger processing, passenger amenities & baggage handling
- 4.2.2.6 Environment and aviation activities: aircraft noise, air quality in the vicinity of airports, global environment problem arising from airport use, water and soil pollution in the vicinity of airports
- 4.2.2.7 Land-use planning: assessing noise for land-use planning, risk of accident around airports

4.2.3 Geometric Design of Aerodrome

- 4.2.3.1 **Design of Runways:** Definitions, aerodrome reference code, factors affecting the sitting, orientation and number of runway, factors affecting length of runway, actual length of runways, Turning pad runways with stop-ways and clearways, Runway endsaftey area (RESA) take-off length requirement, landing length requirement, physical characteristics of:runways, runway shoulders, runway strips, clearways, stopways, obstacle limitation surfaces
- 4.2.3.2 **Design of taxiways, aprons and holding bays:** functional requirements, taxiway width, taxiway curves, junction and intersection, rapid exit taxiways, passenger terminal apron, cargo terminal apron, size of apron, isolated parking bay, need of holding bays and bypasses, types of bypass, size and location of holding bays

4.2.4 Design of aerodrome pavement

- 4.2.4.1 Procedure for pavement design [Aircraft Classification Number (ACN), Pavement Classification Number (PCN) method], USA practices: design of flexible and rigid pavements, (FAA's FAARFIELD method), pavement management system, airport pavement evaluation

4.2.5 Visual Aids for Navigation

- 4.2.5.1 Operational factors, operating requirements, runway, taxiway and apron marking and lighting, airport signs

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4.2.6 STOLPort and Heliport

- 4.2.6.1 **STOLPort:** Physical Characteristics of STOLPorts, importance of STOLPorts in the context of topography of Nepal and their role in the economic development of Nepal
- 4.2.6.2 **Heliport:** Physical Characteristics of Heliports. Obstacle Limitation Surfaces and Requirement

4.2.7 Airport drainage

- 4.2.7.1 Purpose, determination run-off (FAA method), typical drainage layout, sub-surface drainage

4.2.8 Aerodrome Certification and Safety Management System

- 4.2.8.1 Introduction to Aerodrome Certification.
- 4.2.8.2 ICAO and Nepal requirements on Certification of Aerodromes.
- 4.2.8.3 Audit and Inspection of Aerodromes for the Certification.
- 4.2.8.4 Introduction to State Safety Program (SSP) and Safety Management System (SMS)

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, Nepal interim standard of drinking water

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

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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 between maintenance and rehabilitation, Operation of water supply system, Maintenance equipments: wrench

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

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 combinedsewer 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 bio-filters

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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 and introduce following under this heading

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 Environment

- 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

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प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरुलाई मात्र
लिइने सामूहिक परीक्षण (Group Test) को लागि

सामूहिक छलफल (Group Discussion)

यस प्रयोजनको लागि गरिने परीक्षण १० पूर्णाङ्क र ३० मिनेट अवधिको हुनेछ जुन नेता विहिन सामूहिक छलफल (Leaderless Group Discussion) को रूपमा अवलम्बन गरिने छ। दिइएको प्रश्न वा Topic का विषयमा पालैपालोसँग निर्दिष्ट समय भित्र समूह बीच छलफल गर्दै प्रत्येक उम्मेदवारले व्यक्तिगत प्रस्तुति (Individual Presentation) गर्नु पर्नेछ। यस परीक्षणमा मूल्याङ्कनको लागि देहाय अनुसारको ३ जनाको समिति रहनेछ।

आयोगका अध्यक्ष वा सदस्य	-	अध्यक्ष
मनोविज्ञ	-	सदस्य
दक्ष/विज्ञ (१ जना)	-	सदस्य

सामूहिक छलफलमा दिइने नमुना प्रश्न वा Topic

उदाहरणको लागि - उर्जा संकट, गरीबी निवारण, स्वास्थ्य बीमा, खाद्य सुरक्षा, प्रतिभा पलायन जस्ता Topics मध्ये कुनै एक Topic मात्र दिइनेछ।