

प्रदेश लोक सेवा आयोग

गण्डकी प्रदेश, पोखरा

प्रदेश इन्जिनियरिङ्ग सेवा जियोलोजी समूह हाइड्रोजियोलोजी उपसमूह सातौं तह हाइड्रोजियोलोजिष्ट पदको खुला
प्रतियोगितात्मक परीक्षाको पाठ्यक्रम

द्वितीयपत्र (Paper II) : Technical Subject

Section (A) - 20 Marks

1. **Geology and Tectonics of Nepal Himalaya**
 - 1.1 Geological and stratigraphical framework of Nepal Himalaya.
 - 1.2 Engineering geological characteristics of various tectonic zones of Nepal.
 - 1.3 Main characteristics of the major folds and thrust structures of Nepal Himalaya and its stratigraphic implications.
 - 1.4 The study of the Himalayan geology and its inference in infrastructure development.
 - 1.5 Primary and secondary structures in structural geology; importance of regional, local and microstructures in geological mapping and mineral exploration and major geological structures identification. Problems in structural mapping in Nepal Himalaya.
 - 1.6 Pre and post mineralization structures versus control of economic minerals in the Himalayan regions.
 - 1.7 Seismotectonics of Nepal Himalaya: Earthquake seismology, earthquake sources, active faults and seismicity in Nepal Himalaya.
 - 1.8 Paleontology, index fossils, stratigraphy and fossils of Nepal.
2. **Remote Sensing and GIS**
 - 2.1 Development in aerial and space photography, advantages and limitations of photo geological techniques.
 - 2.2 Aerial Photography and Satellite Imagery: Use of conventional aerial photographs and satellite imageries, basic geometrical relations of scale parallax and heights using stereoscopes, quantitative determination of geological data.
 - 2.3 Photo/Image Interpretation: Principles and elements of photo/image for geological applications, interpretation of SLAR imagery.
 - 2.4 Digital Image Processing: Image rectification and restoration. Image enhancement. Contrast manipulation. Spatial feature manipulation. Multi-image manipulation. Image classification. Supervised classification. Unsupervised classification. Classification accuracy assessment.
 - 2.5 GPS: Data acquisition, error in GPS data, applications in mapping and seismic monitoring.
 - 2.6 GIS and Maps: Development of GIS and its uses, GIS data sources and database management. Maps characteristics, projections, coordinate system, precision and error.
 - 2.7 Spatial Data Models: Concept of data model, vector and raster data model, topology, TIN data model.
 - 2.8 Spatial Analysis and Preparation of Maps: Spatial interpolation methods, raster and vector analysis, map overlay, map calculations, statistics, integrated spatial analysis. Map design, map elements, choosing a map type, exporting map in different format, printing a map.

Section (B) - 30 Marks

3. **Mineral Resources and Processing**
 - 3.1 Mineral Resources of Nepal: Metallic, nonmetallic, industrial and fuel minerals; construction materials, block stone, dimension stones and decorative stones.

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- 3.2 Use of physical, optical and other specific properties in mineral identifications.
- 3.3 Determination of minerals by chemical compositions.
- 3.4 Basic principles and objectives of mineral processing/ beneficiation.
- 3.5 Introductory aspects of applicability of mineral concentration techniques such as hand picking, panning, jigging, heavy fluid separation, magnetic separation, decrepitation, agglomeration, floatation, amalgamation, cyanidation, leaching, roasting, smelting, refining and calcinations in mineral concentration/ separation.

4. Mineral Evaluation, Development and Production

- 4.1 Potential, exploration, development and production of mineral resources in Nepal Himalayas.
- 4.2 Global tectonics as guide to mineral deposits, spatial and temporal position of mineral deposits in Nepal.
- 4.3 Estimation, evaluation and assessment of mineral resources in Nepal Himalayas.
- 4.4 Tonnage and grade of various mineral resources in Nepal and adjoining Himalayas: Tonnage, cut-off grade, prices and specification of commodities for mining.
- 4.5 Factors involved in the mineral economics and viability assessment of mineral deposits. Importance of tonnage versus grade in mineral development.
- 4.6 Potential, exploration and development of hydrocarbon or fuel mineral resources in Nepal in particular and in the Himalayan region as a whole.
- 4.7 Prospectivity and exploration of trace elements and gem minerals in Nepal Himalaya and adjoining region.
- 4.8 Application of techniques and methods in open cast and underground mining in Nepal Himalaya and adjoining regions.
- 4.9 Surface exploration versus subsurface exploration and their comparative importance.
- 4.10 Classification of various types of rocks and mineralization associated with sedimentary, igneous and metamorphic terrain.

5. Geophysical and Geochemical Exploration

- 5.1 General principles of geophysical exploration and its applicability and limitations, physical properties involved in geophysical exploration and factors controlling geophysical anomalies, application and significance of local and regional anomalies.
- 5.2 Principles, application and limitation of gravity survey; identification and interpretation of anomalies; importance of correction factors in gravity survey.
- 5.3 Basic principles, application and limitation of magnetic survey; identification and interpretation of anomalies; significance of correction factors in magnetic survey.
- 5.4 Basic principles, application and limitation of Electrical Resistivity, Induced Polarization, Self Potential, Telluric and Electromagnetic methods; basic factors essential in such survey; identification and interpretation of anomalies.
- 5.5 Basic principles, application and limitation of Seismic Reflection and Refraction surveys; factors important in seismic reflection and refraction surveys. Earthquake seismology, seismic waves propagation through interior of earth. Seismic wave velocity model. Recent development in seismic research in Himalayan region particularly in Nepal Himalaya.
- 5.6 Principles of geochemistry, application and limitation of geochemical exploration.
- 5.7 Primary and Secondary Dispersion: Clastic and hydromorphic dispersion; mobility of elements, indicator and path finder elements.

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- 5.8 Trace element abundance in natural materials, common geochemical association of the trace elements in different types of mineral deposits and rocks.
- 5.9 Soil Survey: Drainage sediment survey, Heavy concentrate survey, Water and Vegetation survey, Background and threshold values and geochemical anomalies.
- 5.10 Stages of geochemical exploration.
- 5.11 Analytical methods involved in geochemical exploration, statistical analysis of geochemical data and interpretation.
- 5.12 Dating techniques of rocks and sediments.

Section (C) - 25 Marks

6. Basics of Engineering Geology

- 6.1 Role of Engineering Geology in Different Stages of Project Development: Planning, identification, feasibility, detailed design, evaluation and maintenance stages.
- 6.2 Basic Principle, Techniques of Engineering Geological Study with its Engineering Significance: Geological mapping, engineering geological mapping, use of remote sensing and GIS, geophysical survey and interpretation, in-situ and lab tests. Preparation of engineering geological reports for the projects.
- 6.3 Graphical Presentation of Geological Data: Introduction, equal area and equal angle projections, stereographic projection of a plane and its pole, line and intersection of two planes. Relationship between true and apparent dips, plotting and analysis of field measurements.
- 6.4 Geological Hazards and Applied Geomorphology
 - 6.4.1 Classification of landslides. Landslides in Nepal. Study of an individual landslide. Factors controlling landslide, analysis and control of landslides, problem of landslides, glacier lake outburst flood (GLOF) in Nepal, methods for mitigation. Concept of danger, hazard, vulnerability, and risk analysis. Detection and control of landslide. Basic principle of geohazard management.
 - 6.4.2 Earthquakes, debris flow and soil erosion as geological hazards. Earthquakes: mechanism of earthquakes, magnitude and intensity, liquefaction, earthquake induced landslides, mitigation of earthquake hazard.
 - 6.4.3 Basic principles of geomorphology, geomorphic processes and application of geomorphology for geological and engineering geological study.
- 6.5 Construction Materials: Sources and types of construction material with their geotechnical and geochemical properties. Method of investigation, testing and quantification of construction materials. Use of various maps (geological, engineering geological and topographic maps) and aerial photographs in search of construction materials.

7. Soil and Rock Mechanics

7.1 Soil Mechanics

- 7.1.1 Soil Formation, Classification and Exploration: Introduction, nature, and composition of soils, soil formation, soil classification, soil exploration, in-situ and laboratory testing.
- 7.1.2 Strength and Deformation: Introduction, principle of effective stress, concept of failure, principles of strength and deformation testing, field testing for strength and deformation. Laboratory tests, strength and deformation parameters of soils.
- 7.1.3 Flow of Water through a Soil Mass: Introduction, flow laws, field measurement of permeability, flow rate, flow nets, solutions of flow equations.

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- 7.1.4 Settlement and Consolidation: Introduction, compressibility of soils, rate of primary settlement, multidimensional settlement, secondary compression, measurement of soil parameters.
- 7.1.5 Retaining Structures: Introduction, limiting stress state in a soil mass, intermediate stress state pressures on a rigid retaining wall, passive pressure analyses, stability analysis.
- 7.1.6 Stability of Slopes: Introduction, types of instability mechanisms, methods of stability analysis, applicability of stability analysis.
- 7.1.7 Foundations: Introduction, foundation systems, stability analysis, stress distribution analysis, settlement analysis of shallow foundations, settlement analysis of foundations, dynamic analysis of foundation.
- 7.1.8 Soil Treatment: Introduction, types, surface and subsurface soil treatment.

7.2 Rock Mechanics

- 7.2.1 Use of Rock Mechanics in Engineering: Introduction, classification of rock and rock mass. Geological factors affecting strength of rock and rock mass.
- 7.2.2 Strength of Rock and Rock Mass: Introduction, brittle and ductile behaviour, laboratory testing of intact rock samples, an empirical failure criterion for rock, use of rock mass classification for rock strength prediction. Approximate equations defining the strength of intact rock and heavily jointed rock masses.
- 7.2.3 Classification of Rock Masses: Introduction, Terzaghi's rock load classification, classifications by Stini and Lauffer, Deere's rock quality designation (RQD). Influence of clay seams and fault gouge. CSIR classification of jointed rock mass. NGI tunnelling index, discussion on rock mass classification systems.
- 7.2.4 Stress around Underground Excavations: Introduction, components of stress, two-dimensional state of stress, stress distribution around single excavation, stresses around a circular excavation, calculation of stresses around other excavation shapes. Stresses around multiple excavations.
- 7.2.5 Underground Excavation: Engineering geological tests (both in-situ and laboratory) for planning, design and execution of underground excavation.

8. Engineering Structures and Engineering geology

8.1 Dams:

- 8.1.1 Introduction, types of dam, classification according to use, hydraulic design, used materials.
- 8.1.2 Physical Factors of Dam Selection: Topography, geology and foundation conditions, materials availability, spillway, size and location, earthquake and available technology.
- 8.1.3 Surface Investigation of Dam Site: Fluvial soils, glacial deposits, residual soils, colluvial soils.
- 8.1.4 Subsurface Exploratory Methods: Test pits, trenches, and test adits. Auger boring, rotary drilling, geophysical exploration.

8.2 **Irrigation canals:** Site selection, problems of instabilities, erosion and sedimentation, measures for their control.

8.3 **Tunnels:** Classification and nomenclature, surface and subsurface exploration for tunnel, determination of rock loads, methods of tunneling including NATM, case histories of tunnels in Nepal.

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8.4 **Roads, bridges and buildings:** Location and site selection, use of engineering geological maps and aerial photographs for road corridor building site studies. Problem of slope stability and erosion, drainage, landslide hazard maps, stable cut slopes in soil and rocky areas: subsurface exploration for bridge and building foundation, construction materials.

Section (D) - 25 Marks

9. **Origin, Occurrence and Movement of Groundwater**

Groundwater occurrence, unconfined and confined aquifers, influent and affluent streams, factors influencing infiltration, groundwater flow, lithology of aquifers, Darcy's Law, porosity, permeability, hydraulic gradient, safe yield, groundwater storage. Factors affecting infiltration capacity, soil moisture, compaction due to rain, compaction due to man and animals, methods of determining infiltration, infiltrometers.

10. **Groundwater Exploration**

Geologic and Hydrologic studies

Stream Flow Records: Methods of obtaining discharge records, measurement of velocity, calibration of current meter, type of current meters, methods of making discharge measurements.

Water Losses: Evaporation from free water surfaces, evapotranspiration, influence of depth, methods of determining evaporation, influence of high or low water table, measurement of soil evaporation, total water loss, factors affecting total water loss.

11. **Well drilling and well design**

11.1 Basic principles of well drilling, cable-tool percussion method, direct rotary drilling, drilling fluid and drilling mud, reverse circulation drilling, jet drilling, air rotary drilling, driven wells, pipe casing selection, grouting and sealing casing, plumbness and alignment.

11.2 Grain-size analysis, plotting sand analysis curves, types of grain-size curves, well depth, selection of housing and casing pipe (casing diameter, casing material), well screen design (screen length, well screen diameter, well screen slot openings, selection of well screen material), installation of well screens, formation stabilizer, entrance velocity, gravel pack design, sanitary protection.

11.3 Well Point System: Multiple wells for water supply, installing well points, dewatering well point systems, design and layout.

12. **Development of Wells**

12.1 Importance of development work, sand bridging, mechanical surging, surging with compressed air, over pumping, back washing, high velocity jetting, successful development procedures.

12.2 Water Well Pumps: Kinds of pumps, suction and cavitation, positive displacement pumps, variable displacement pumps, centrifugal pumps, jet pumps, air lift pumping, pump selection.

12.3 Measuring pumping rates, water level measurements, aquifer tests, estimating well yield, estimating open pipe flow, equilibrium well equation, yield vs. well size, yield vs. draw down, non-equilibrium well equation, modified nonequilibrium equation, time-drawdown relations, boundary effects, distancedrawdown relations,

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partial penetration of aquifers, water level recovery, well interference, radius of influence, well efficiency.

13. Groundwater Quality and Water Treatment

Chemical components affecting groundwater quality (atmospheric, human and industrial waste, agricultural practices, disasters), processes affecting groundwater quality (soil type, human activities, and groundwater flow on contaminants), groundwater quality monitoring (selection of water quality parameters, sampling methods and density of observation networks, data processing and analysis, preventing measures and implementation), determining groundwater quality, (chemical, physical, and biological), units of measurements, water quality requirements, drinking water standards, aeration softening, demineralization, disinfecting wells-use of hypochlorites, chlorination.

14. Groundwater Resources of Nepal and Conservation and Management of Groundwater

14.1 History of groundwater study in Nepal, review of hydrological data, groundwater resources, groundwater use, groundwater recharge calculation, methods of groundwater estimate, groundwater balance.

14.2 Conservation attitudes, optimum development of aquifers, subsurface water storage, artificial recharge, conjunctive management of groundwater and surface water, pollution control, groundwater level control-structural measures, administrative measures, monitoring, implementation measures for groundwater management.

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प्रथम चरणको लिखित परीक्षाबाट छनौट भएका उम्मेदवारहरूलाई 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।

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।