B.Sc. I Year
Geology (GEO.101)

B.Sc. Year I
Subject: Fundamentals of Geology, Crystallography and Mineralogy, Structural Geology
Nature of course: Theory Course No.: GEO.101
Full marks: 100 Total period: 150
Pass marks: 35

Fundamentals of Geology

Total marks: 40 Total period: 62

Main Topics	Contents	Period	Marks
Introduction	The science of geology, scope, its various branches, method of study, application of geology in mineral resource, infrastructure developments, disaster mitigation.	4	12
Minerals	Definition, processes of formation, and classification of minerals	4	
Rocks	Classification of rock, rock cycle	4	
Earth's interior	Probing e Earth's interior, internal structure of the Earth, Earth's major internal boundaries, the crust, mantle and core, lithosphere and asthenosphere, pressure, temperature and seismic wave velocities inside the earth.	4	16
Earthquake	Earthquakes and faults; elastic rebound theory, seismic waves; seismograph, magnitude and intensity of earthquakes, world distribution of earthquakes, forecast and prediction of earthquakes	4	
Introduction to Plate tectonics	Continental margins, ocean basin floor, mid ocean ridge, Ocean trenches; earlier theories on geosynclines and continental drift; global plate systems, seafloor spreading and subduction zones; theories on coral reef development	8	
Isostasy	Gravity and continental crust.	2	16
Geological structures	Primary structures: Bedding, cross-laminations, ripple marks. Secondary structures: Faults, Folds, Foliation, Joints	4	
Weathering and mass wasting	Earth's external processes, weathering, soil formation, the soil profile, types and causes of mass wasting	6	
Geological work of running water	Runoff and discharge, geological importance of running water, process of stream erosion and deposition, floods	4	
Groundwater and its geological activities	Groundwater movement, water table, aquifers and aquicludes, wells, springs, geologic work of groundwater,	4	**16**
Glaciers and glaciations	Types of glaciers, glacier erosion and transportation, landforms associated with glaciers	4	
Geological work of sea and ocean	Geological work of sea and ocean and associated landforms	4	

Geological work of wind	Wind erosion, transportation, and deposition, eolian landforms	4	

Crystallography and Mineralogy

Total marks: 30 **Total period: 44**

Main Topics	Contents	Periods	Marks
Introduction to crystallography	Definition of crystals, Crystal symmentry elements, crystal face, Bravais law, law of constancy of interfacial angles, Crystallographic axes	2	16
Internal order in crystals	Symmetry operations, unit cell, lattice; Thirty-two point groups and their symmetry elements; Bravais lattices, screw and glide symmetries, concept of space group and international space notation	4	
Morphology of crystals and Crystal systems and classes	Axial ratios, parameter system of Weiss, Miller indices, forty-eight forms, combination of forms; Crystal systems: Classes and forms of Triclinic, monoclinic, orthorhombic, hexagonal, tetragonal and isometric systems	8	
Crystal growth and twining	Growth of crystals from solution and from a melt under controlled conditions, crystal growth in open fractures, solution cavities, or vesicles, Twining in crystals, different types of crystal twins, causes of twining in crystals, twin laws.	2	
Introduction to mineralogy and physical properties of minerals	Definition of mineral, scope of determinative mineralogy Scalar properties–colour, lustre, and streak, their definition and varieties with examples, specific gravity, determination of specific gravity of pure mineral grains by sink and float method, fluorescence and phosphorescence, magnetic properties–ferromagnetic, paramagnetic, and diamagnetic minerals.	6	16
Crystal chemistry of minerals	Vector properties–cleavage, parting, and fracture, their definitions, mineral examples, hardness–definition, Moh's scale of hardness, determination of hardness of minerals, crystallinity and forms of minerals–crystalline, cryptocrystalline, and amorphous, habit of minerals– elongated, tabular, flattened, and equant forms of crystalline and cryptocrystalline aggregates–type examples and use in identification. (a) Concept of crystal structure of minerals, Crystal structures and lattices of cubic system; dimorphism, polymorphism, and pseudomorphism, isomorphism and solid solutions.	6	
Chemical properties of minerals	Minerals as a chemical system; native elements, sulphides, halides, oxides, silicates, titanates, phosphates, arsenates and vanadates, nitrates, borates and uranates, sulphates and chromates, tungstates and molybdates, oxalates and hydrocarbons. Rock-forming	4	

	(silicate) minerals and their classification.		
	Introduction to economic minerals of Nepal	4	
Introduction to optical mineralogy	Elements of optics, optics of isotropic medium– refractive medium, Snell's law; critical angle; anisotropic media, polarisation and interference of light, Polaroid, polarising microscope–construction and use, magnification and resolving power, construction and use of mica and gypsum plates and quartz wedge, pleochroism and birefringence, optical indicatrices – uniaxial and biaxial indicatrices, behaviour of light in uniaxial and biaxial crystals, optic sign, optical properties of minerals – form, cleavage, fracture, and parting, refractive index and relief, Bécké line and its use, twining, colour, and pleochroism, pleochroic forms of common minerals, properties under crossed polarisers – interference colour, twining, and extinction angle, anomalous interference colours, Michael Lévy chart and its use in determining thickness, path difference, birefringence, and order of interference colour, interference figures, optic sign of anisotropic medium, dispersion of optic axes in biaxial crystals.	4	**12**
Mineral Genesis & Mineral classification	Formation of minerals by different endogenous and exogenous processes. Rock-forming (silicate) minerals and ore-forming (non-silicate) minerals. Silicate Classifications. Physical and optical character, mode of occurrence and important rock-forming minerals.	4	

Structural Geology

Total marks: 30 **Total period: 44**

Main Topics	Contents	Periods	Marks
Introduction	Introduction: Definition, scope of structural geology, concepts of detailed structural analysis: descriptive, kinematic, and dynamic analysis.	4	12
Geological map and cross-section	Geological map and cross-section, orientation of a line (trend and plunge) and a plane (dip and strike), use of a geological compass in measuring orientation of a line and a plane.	4	
Stereographic projection	Introduction to stereographic projection and its application in structural geology, plotting a line and a plane, finding the intersection of two planes, apparent and true dips.	4	
Stress and strain	Concepts of stress and strain, their definitions, stress in two dimensions, Mohr circle and its use.	4	
Unconformity	Bedding, conformity, and unconformity, types of unconformity, recognition of various unconformities in maps and cross-sections.	2	16
Intrusive contacts	Main features of intrusive contacts, sills and dykes, batholiths.	2	
Diapirs	Main features of diapirs and salt domes.	2	
Primary structures	Types of primary sedimentary and igneous structures and their application in structural geology, cross-cutting relationships and younging directions.	4	
Folds	Definition, classification of folds: anticline and syncline, antiform and synform, cylindrical and non-cylindrical folds, drag folds, criteria of recognition of folds in the field.	6	
Faults	Definition, classification of faults: strike slip, normal, and reverse faults, thrust faults, horst and graben, criteria of recognition of faults in the field.	6	16
Joints	Definition and classification of joints, study of joints in the field.	4	
Foliation and lineation	Cleavage, schistosity, and foliation, lineations and their classification, relationship of foliation and lineation with other structures in the field.	3	
Concepts of field geology	Topographic and geological map reading, use of geological compass, methods of plotting geological data on the maps and preparation of cross-sections.	3	

B.Sc. II Year
Geology (GEO.201)

Subject: Petrology, Paleontology & Historical Geology, and Sedimentology
Nature of course: Theory Course No.:(GEO.201)
Full marks: 100 Total period: 150
Pass marks: 35

Petrology

Total marks: 40 Total period: 62

Main Topics	Contents	Period	Marks
(a) Igneous Petrology			
Introduction	Nature and scope of petrology, difference between petrology and petrography, General classification of rocks: igneous, sedimentary and metamorphic, general characteristics of igneous, sedimentary and metamorphic rocks.	2	24
Magma	Magma: Definition, composition, physico-chemical constitution, primary magma, magmatism in different tectonic environments.	2	
Evolution of magmas	Magma differentiation: fractional crystallization, other differentiation mechanisms, Magmatic mixing and assimilation.	2	
Forms and structures of igneous rocks	Intrusive igneous rocks: intrusive rocks and their relation to geological structures, intrusive forms, method of emplacement of intrusive rocks. Extrusive igneous rock: their structures and forms	4	
Textures and microstructures of igneous rocks	Crystallinity, granularity, crystal shapes and mutual relations among minerals, glasses.	2	
Crystallization of silicate melts	Unary and binary systems. Phase relations and textures, Ternary systems: Simple and complex, the effects of pressure on melting and crystallization of magma.	4	
Classification and description of igneous rocks	The IUGS classification system, chemical classification, characteristics of common igneous rocks: plutonic and volcanic, description of common igneous rocks.	4	
Formation of magma	Formation of magma: Rift zones, melting processes: partial melting, observations at the Mid-Oceanic Ridges.	2	
Igneous rocks in different tectonic settings	Igneous rocks at continental margins: Ophiolite suite, calcalkaline and tholeiite groups, plutonic rocks: batholiths related to subduction zones. Continental igneous rocks: gabbroic layered intrusions, anorthosite, alkali basalt and nephelinite, carbonatite, kimberlite and related rocks.	2	

(b) Metamorphic Petrology			
Metamorphism	Definition, types of metamorphism: regional, contact, burial, cataclastic, progressive, retrograde, inverse.	2	20
Metamorphic rocks	Definition, recognition in the field, distribution and nomenclature, structures and textures of metamorphic rocks. Shape of minerals, growth and mutual relation of minerals, petrographic descriptions of slate, phyllite, schist, gneiss, amphibolite, marble, quartzite, hornfels, serpentinite, granulite and eclogite. Control of metamorphism: pressure, temperature and composition in metamorphism.	4	
Metamorphic processes	Initiation of metamorphism, contact metamorphism, metamorphism of igneous rocks, submarine metamorphism, porphyroblasts, preferred orientation, metamorphic differentiation: compositional gradient, temperature gradient, differentiation by deformation, metamorphic reactions, the upper limit of metamorphism.	4	
Metamorphic zones	Index minerals, zones in contact metamorphism, isograds: Definition, dependence on temperature and pressures.	2	
Metamorphic facies and graphic representation	Definition of facies, evolution of concept of metamorphic facies. major metamorphic facies, phase rule, relationship of zones, grades and facies, graphic representation of ACF, AKF and AFM diagrams.	4	
Mineralogical phase rule	Invariant, bivariant reaction, invariant point and their significance (Triple point of Al_2SiO_5 and those in metamorphism of argillaceous rocks). Mineral variation related to initial rock composition: Carbonate rocks, mud rocks, mafic igneous rocks and tuffs, ultramafic rocks.	4	
(c) Sedimentary Petrology			
Introduction	Distribution of sedimentary rocks in time and space, formation of sediments, sediments and climate, tectonic setting of sediment accumulations.	2	18
Sedimentary textures	Size of sedimentary particles, Shape of sedimentary particles, concept of textural maturity.	4	

Sedimentary structures	Erosional, depositional and synsedimentary deformational structures and their significance.	4	
Classification of Sedimentary rocks	Classification based on texture and composition, genetic classification; Definitions, texture and structures, composition, and classification of sandstones, conglormerates, mudrocks, limestones and dolostones. Introduction to other sedimentary rocks: evaporites, bedded cherts, bedded phosphate rocks, bedded iron deposits.	6	
Diagenesis of sediments	Diagenetic stages and regimes, diagenetic processes: compaction, cementation, dissolution, replacement, recrystallization, authigenesis.	2	

Paleontology and Historical Geology

Total marks: 30 Total class hours: 44 hrs

Main Topics	Contents	Periods	Marks
Introduction	Aim, scope and objectives of paleontology, fossils and fossilization, index fossil, types of fossils, their mode of preservation, Importance of fossils, life through geological ages, organic evolution, evolution of life, Species: definition, concept and method of nomenclature, functional morphology	6	16
Invertebrate Fossils	Classification, geographical and geological distributions, morphology, Evolution and Evolutionary trend, Phylum Protozoa (*Foraminfera)* Coelenterate (*Anthozoa*), Arthropoda (*Trilobite*), Brayozoa, Brachiopod, Mollusca (*Bivalve, Gastropod, Cephalopoda*), Echinodermata (*Echinoidea),* Hemichordata (*Graptoloidea*), Introduction of animal microfossils and applications (Radiolaria, diatom,Ostracoda/ Conodont), Introduction to trace fossils and their applications.	10	
Vertebrate Fossils and Paleobotany	Geological history through time of the following vertebrate groups: *Fishes, Amphibians, Reptiles, Aves and Mammals, Equidae, Proboscides and Hominidae* Plant fossils: Plant life through time (*Psilopsida, Lycopsida, Sphenopsida and Pteropsida*) Gondwana flora, Evolution of Angiosperms. Introduction to plant microfossils (pollen and spores, diatoms) and applications.	4	14
Introduction to Historical Geology	Scope, aim, method of study, development of historical geology, problem of historical geology, the interrealtion of historical geology to other geological sciences, the geological time scale.	2	
Origin of the Earth and life	Origin of solar system, evolution of the Earth, development of the atmosphere, hydrosphere and biosphere, theory of origin of life, the first sign of life on the Earth, index fossils.	4	
Time on rock record	Introduction to relative and absolute time, Unit and measurement of geological time, geochronology,	4	

	relative age determination, time stratigraphic units, introduction of lithostratigraphy, biostratigraphy, magnetostratigraphy and chronostratigraphy, method of correlation.		
The main tectonic unit of the Earth's crust and their evolution	Principal tectonic units of the present continents, the tectonic elements of oceans, tectonic evolution of the earth's crust.	2	14
Principles of paleoenvironment, Paleogeography, Paleotectonics	Introduction to marine and non-marine environments, Study of paleo-environments including the influence of organisms on sediments, methods of paleogeographic reconstruction, epirogenic movement of the crust, the analysis of the geological sections as a method of reconstructing crustal movements, methods of reconstruction of plaeotectonics	4	
The earliest (Precambrian) history of the earth's crust	The duration of the Precambrian era and the earliest known state of the crust, Development of Archean Cratons, the Precambrian shield rocks, Paleogeography during Precambrian, and Precambrian glaciations.	4	
Geological history of Phanerozoic eon	Plate position and motion, organic evolution, paleogeography and the crustal movements during the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Palaeogene and Neogene.	4	

Sedimentology

Total marks: 30 Total class hours: 44 hrs

Sedimentology			
Introduction	Definition of Sedimentology, History and development of sedimentology, Sedimentary rocks in space and time. Scope of sedimentology	2	44
Sedimentary processes	Physical processes: Fluid flow, Reynolds Number, Transport mechanisms: bedload and suspended load transport, transport in solution, Froude Number, Flow regimes and their significance, Flow regime and bed-forms, stream power and water depth, depth-velocity diagram. Subareal and subaqueous transport: Lahar, debris flows, turbidity currents and resulting bedforms	6	
	Chemical processes: Redox potential, pH, Eh-pH diagram, Geochemical Fence Diagram, Chemical processes of sedimentation: Dissolution, precipitation, formation of nodules and concretions	6	
	Biological processes: Metabolic process and hard parts generation, baffling and trapping, boring and chipping, pelletization, symbiotic relations among organisms, and microbial processes in generation of sediments.	4	
Depositional environments	Concept and classification of depositional environment	2	
	Continental Environments: Depositional settings, introduction to sedimentation processes of Fluvial, Lacustrine, Glacial and Eolian deposits.	8	
	Transitional Environments: Depositional setting, introduction to sedimentation processes of Deltaic, Estuarine, Barrier Beach Complex, and Tidal deposits.	8	
	Marine Environments: Depositional settings, introduction to sedimentation processes of Shallow Marine and Deep Marine deposits.	8	

B.Sc. III Year
Geology (GEO.301)

Subject: Geology of economic mineral deposits, Stratigraphy & Geology of Nepal, Geochemistry & Geophysics
Nature of course: Theory Course No.: GEO.301
Full marks: 100 Total period: 150
Pass marks: 35

Group A: Geology of Economic Mineral Deposits

Total marks: 25 Total period:38

Main Topics	Contents	Period
Introduction	Mineral deposits and ore fields, ore genesis, ore texture and structures, mineral association, stages of mineralization, ore reserves, ore and gangue minerals, workable limits, Mineral resources: economic, sub-economic ore deposits/ prospects and occurrences. Grade, Tenor & Tonnage ore.	4
Formation of Mineral Deposits	Magmatic concentration, sedimentation, metamorphism, contact metasomatism, hydrothermal deposits, oxidation and supergene enrichment, sublimation and evaporation, residual and mechanical concentration (heavy mineral concentrate/ placer deposits), Bactereogenic deposit. Submarine Exhalation and volcanogenic deposit.	12
Distribution of mineral deposits	Mineral paragenesis and zoning, metallogenic epochs and provinces; geological controls on location of mineral deposits.	4
Metallic deposits	Classification: Precious metals, Ferrous metals; Non-ferrous metals, Light metals, Radioactive metals, and Rare metals, Rare Earth Elements. Chemical composition, important physical properties, mode of occurrence, utilization and world distribution (including Nepal): ores of lead, zinc, copper, Nickel, Cobalt, Aluminum, iron and gold, rare earth elements.	8
Non-metallic Deposits:	Classification: Fossil fuels, gemstones, abrasives, construction materials and decorative stones, industrial minerals. Chemical composition, important physical properties, mode of occurrence, utilization and world distribution (including Nepal): magnesite, limestone, coal, petroleum and some selected gem stones (quartz, garnet, ruby, tourmaline, beryl).	10

Stratigraphy and Geology of Nepal

Total marks: 50 Total period: 75

Main Topics	Contents	Period
Stratigraphy		
Fundamentals of Stratigraphy	Aim, scope, origin and development of basic principles and establishment of stratigraphic units.	4
Stratigraphic classification and Nomenclature	Stratigraphic classification, Naming of stratigraphic units, lithostratigraphic, biostratigraphic, chronostratigraphic and magnetostratigraphic units. Formal and informal units.	10
Stratigraphic correlation	Criteria of correlation, lithostratigraphic, biostratigraphic, chronostratigraphic, magnetostratigraphic units/succession.	10
Establishment of stratigraphic units	International guide and code on stratigraphic classification and nomenclature, Preparation of columnar sections, classifications, naming, dating and publication. Revision of stratigraphic units. Homonyms, synonyms. Major standard stratigraphic units and index fossils. Introduction to sequence stratigraphy.	13
Geology of Nepal		
Broader framework and sub-divisions of the Himalaya	Relation of the Himalaya with other mountain chains of the region, Geomorphic sub-divisions, tectonic sub-divisions. Introduction to the geology of adjoining regions.	6
Stratigraphy of the Nepal Himalaya	Established stratigraphy of the Sub-Himalaya, Lesser Himalaya, Higher Himalaya and Tethys Himalaya. Quaternary successions of the Kathmandu basin, Pokhara basin and Thakkhola basin. Indo-Gangetic Plain.	10
Evolutionary history of Nepal Himalaya	Precambrian, Paleozoic, Mesozoic and Cenozoic evolutionary history of the Himalaya (sedimentation, tectonics, metamorphism, magmatism)	14
Mineral Resources of Nepal	Geological controls on metallic and non-metallic mineral deposits, precious and semi-precious stones, fossil fuels, coals and hot springs of Nepal. Current status of mineral resources development of Nepal.	8

Group C: Geochemistry and Geophysics

Total marks: 25 Total period: 37

Main Topics	Contents	Period
Introduction to geochemistry	Definition, principles and scope of geochemistry.	2
The structure and composition of the Earth	Internal and/or zonal structure of the Earth, composition of the crust, composition of the Earth as a whole, pre-geological history of the Earth.	6
Geochemical classification and differentiation	Geochemical classification of the elements, primary and secondary differentiation of the elements,	6
Geochemical cycle	Earth as a physicochemical system, the crust as a separate system, the geochemical cycle. Energy changes in the geochemical cycle.	4
Introduction to geophysics	Introduction to geophysics, application, limitations and ambiguity.	2
Gravity method	Introduction to gravity method, Gravitational field (force and potential), gravity instuments (gravimeters and variometers), gravity anomalies (Bouguer Anomaly), application and limitation.	4
Electrical method	Electrical properties of rocks, electrical field caused by a point charge, electrical survey methods, application and limitations.	7
Seismic method	Sources of seismic energy. Principles, applications and limitations of Seismic refraction and reflection methods.	6

B.Sc. IV Year
Geology (GEO.401)

Subject: Exploration Geology and Mining Geology

Nature of course: Theory | Course No.: Geo.401
Full marks: 100 | Total class period: 150
Pass marks: 35

A. Exploration Geology

Total period: 75 | Total Marks: 50

Main Topics	Contents	Period
Introduction	Importance of mineral resources. Stages of mineral resource development: prospecting, exploration, mining, processing and marketing. Factors affecting the distribution and localization of mineral deposits. Prospecting criteria, guides, wall rock alteration, primary and secondary haloes, metallogeny, metallogenic epochs, provinces, prognostic maps.	**20**
Exploration	Reconnaissance, prospecting, pre-feasibility, feasibility, engineering and mine exploration. Exploration methods: geological reconnaissance traverse, panning, remote sensing-landsat system, photogeology. Application of geophysical methods for mineral exploration: magnetic survey, gravity survey, radiometric survey, resistivity, seismic methods, Ground Penetration Radar (GPR) and borehole geophysics. Application of geochemical methods for mineral exploration: geochemical anomalies, background, threshold, pathfinder elements, geochemical methods: metallometric, hydrochemical, geobotanical and gas prospecting. Exploration openings: pitting and trenching, drilling and underground excavations, sampling and acquiring geological and geotechnical data.	**30**
Evaluation of deposits	Reserve estimation, grade calculation,workable standards. Economic, sub-economic and non-economic deposits.	**10**
Mineral Resources of Nepal	Geological controls, current status and future prospects of different mineral resources of Nepal. Metallic, nonmetallic and fossil fuels.	**15**

B. Mining Geology

Total period: 75 Total Marks: 50

Main Topics	Contents	Period
Introduction	Introduction to Minerals, Mines and Exploration Methods: Mineral resources, Mineral/Ore deposit/ prospect, Mine/ Quarry, Mining of Metallic and Nonmetallic Minerals: Ore Minerals, Industrial Minerals, Precious and Semi-precious stones, Dimension/ decorative stones, Construction Materials/Minerals. Fuel Minerals.	**2**
Mining Terminology	Mine opening, important parts of a mine, trench, pit, shaft, tunnel, adit, excavation, level, crosscut, stopping, loading, dumping, mine environment, mine ventilation, mineral transport system, mine drainage, light system, fire safety measures.	**10**
Mining methods and Technology	Definition, Mine and Mining, Stripping ratio, Ore and waste, Mine development, Mining plan, Mining methods and their selection, Type of Mines, Surface and Underground mine with examples from Nepal, Mine operation, Production, Sequences in the life of mine, Mine safety, Occupational health, Mine excavation.	**15**
Drilling and blasting methods, Mining equipments and machines	Shot hole drilling, Explosives, blasting methods, Excavator, loader, dumper, bulldozer, rock breakers.	**10**
Ore processing and dressing	Crushing, Grinding, washing, pulverizing, concentration, storage/stockpile/dumping site and waste management.	**8**
Mineral Industries	Basic infrastructures, mineral based industries examples, regular supply of materials (ore/ raw materials) to the industries, industrial production, quality of the product, quality control, regular supply in the market, market study.	**3**
Basic Mineral economics	Mine operation cost, production cost, market price/ selling price, internal and external price (ROM/CIF/FOB), Demand and supply situation, introduction to cost benefit analysis, Net Present value (NPV), Internal Rate of Return (IRR), Contribution to National GDP from mineral, mine, mining and Mineral industry sector.	**15**
Existing Mines and Mineral Act	Existing Mines and Mineral Act-2042 and Mines and Mineral Regulations-2056, Lease system, Prospecting License, Mining License, Government Policy, License fee, surface rental, Government taxes, royalties, local taxes and benefits, royalty in production. Petroleum act-2040 and regulation-2041, environmental act-2053 and regulation-2054 with	**12**

	amendments.	

B.Sc. IV Year
Geology (GEO.403)

Subject: Engineering Geology and Hydrogeology
Nature of course: Theory Course No.: Geo.403
Full marks: 100 Total class period: 150
Pass marks: 35

A. Engineering Geology

Total marks: 50 Total Period: 75

Main Topics	Contents	Period
Introduction to engineering geology	Development of engineering geology, aims of engineering geology, essential definitions.	**2**
Description, properties and behavior of soils and rocks:	Engineering soil classification, coarse soils, silts and loess, clay deposits, tropical soils, dispersive soils, soils of humid and arid regions, tills and glacially associated soil, frost action in soil, organic soils, peat, description of rocks and rock masses, engineering aspects of igneous, metamorphic and sedimentary rocks.	**5**
Geological materials	Important characteristics of geological materials, sediments, intact rock materials, fluids and gasses, description of geological materials, material properties and their measurement, types of test, limitations of testing, size and shape of sample, standards, density and unit weight, porosity and permeability, strength, types of rock deformation, consolidation of soils, Abrasiveness, environmental reactivity, index tests, range of values for soils and rocks, field test of soils and estimation of soil parameters.	**8**
Geological masses	Discontinuities, shear strength and discontinuities surface characteristics, field estimate of discontinuity friction angle, persistence, orientation, spacing, influence of weathering on rock mass properties, standard weathering description and weathering zonation, drilling and sampling in soils, drilling and sampling in soil and rocks, core logging for ground description.	**7**
Engineering geology of slopes	Landslides and their classifications, landslide recognition and identification, rate of landslide movement, extent of landslide, causes and mechanism of failures, the stability of slopes in soil, benching on slopes, slope drainage, effect of excavation technique on slope stability, slope stability analysis in rock, kinematic analysis of rock slopes, use of stereonets for rock slope failure analysis, rock mass rating (RMR) and Q-system, slope mass rating (SMR), severity of	**8**

	slope instabilities and remedial works.	
Engineering geological maps	Published geological and engineering geological maps, engineering geological map making, understanding of geological maps, interpretation of geological maps for engineering purpose, mapping at a small scale, mapping at a large scale specially for foundation areas and excavations, rock slopes, outcrops, tunnels, mines, natural cavities, symbology in engineering geological maps, quality of published information	**6**
Geological materials used in construction	Building or dimension stone, roofing and facing materials, armourstone, Crushed rock: concrete aggregate; road aggregate; gravels and sands; lime, cement and plaster; clays and clay products.	**5**
Excavation and ground loading	Excavation issues, blasting, ground improvement, site investigation for underground excavations, subsidence, types of foundation, ultimate bearing capacity, safe bearing capacity and allowable pressures, bearing capacities on boulder bearing soils, settlement on soils, bearing capacity on rock masses, foundation settlement on rock, Foundations on slopes.	**7**
Engineering geology and construction	Open excavation, tunnels and tunnelling, underground caverns, shafts and raises, reservoirs, dams and dam sites, highways, railroads, bridges, buildings.	**5**
Field tests and measurements	Tests in boreholes, tests in large diameter boreholes, shafts and tunnels, measurements in boreholes and excavations, choice of geophysical methods, seismic methods and their particular applications, use of electrical resistivity methods, magnetic methods and gravity methods in engineering geological site investigation.	**7**
Engineering geology and earthquakes	Characteristics of Earthquakes (magnitude, intensity), ground response analysis, assessing seismic risk and seismic hazard, ground engineering design against earthquake hazards.	**5**
Design and reporting of site investigations	Introduction, stages of Investigation, design of site investigations, progressive evaluation of site investigation data, investigation progress, supervision of investigating works, investigation reports, form of the report.	**5**
Engineering geology, planning and development	Introduction, geological hazards, risk assessment and planning, landslide hazard maps, derelict and contaminated land.	**5**

B. Hydrogeology

Total marks: 50 Total Period: 75

Main Topics	Contents	Period
Soil moisture and groundwater	Porosity of earth materials, classification of sediments, forces acting on groundwater, vertical distribution of groundwater, water table, infiltration, soil moisture, permeability of sediments.	**5**
Geology of groundwater occurrence	Aquifers, types of aquifers, Unconsolidated aquifers (alluvial valleys, alluvium in tectonic valleys) Rocks as aquifers.	**8**
Groundwater exploration	Surface and subsurface investigations of groundwater: Geological methods, remote sensing, test drilling, geophysical logging (resistivity logging, spontaneous potential logging and other subsurface methods.	**8**
Groundwater movement	Darcy's Law, groundwater flow rates, specific yield, hydraulic conductivity of earth materials (Darcy's experiment, hydraulic conductivity, permeability of sediments, permeability or rocks), storage coefficient, effective porosity, groundwater flow directions, general flow equations.	**10**
Water wells	well drilling methods (direct rotary, reverse rotary, percussion, down the hole, types and applications of drilling fluids, well screens and their types and method of sediment size analysis, water well designs, casing diameter, casing materials, well depth, well screen length, well screen slot openings, open area, entrance velocity, design of wells. Installation and removal of well screens, well development methods, aquifer development techniques, factors that affect development. Pumping test, conducting a pumping test, measuring drawdown in wells, well efficiency, step drawdown test, problems of pumping test analysis. multiple well systems, well losses and specific capacity, Thiem equation, Theis equation, Cooper-Jacob equations, Hantush equations and their applications. Water well pumps:	**22**
Groundwater quality and pollution	Sources of salinity, measures of water quality, chemical analysis, Graphic representations, physical analysis, biological analysis, groundwater samples, water quality criteria, changes in chemical composition, dissolved gases, temperature, water pollution due to mining, agricultural sources of pollution. Water quality protection for wells and nearby groundwater resources.	**7**
Groundwater development and management	Dynamic equilibrium in natural aquifers, groundwater budgets, management of potential aquifers, water law, conjunctive use of groundwater and surface water. Groundwater monitoring technology, artificial recharge, groundwater modelling,	**7**
Groundwater resources of	Distribution, utilization, quality, and management. Types of aquifer and springs in different geological regions of Nepal.	**8**

Nepal	Groundwater legislation.	