B.Sc. II Year

Geology (GEO.201)

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

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	Scope, aim, method of study, development of historical geology, problem of historical geology, the interrealtion of	2	

Historical Geology	historical geology to other geological sciences, the geological time scale.		
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, relative age determination, time stratigraphic units, introduction of lithostratigraphy, biostratigraphy, magnetostratigraphy and chronostratigraphy, method of correlation.	4	
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	

Text and Reference books

Petrology:

A. R. Philpotts, 2009, (2nd edition). Principles of Igneous and Metamorphic Petrology, Prentice-Hall of India Pvt. Ltd, New Delhi, India.

E. G. Ehlers and H. Blatt, 1987. Petrology: Igneous, Sedimentary and Metamorphic. CBS Publishers & Distributors, New Delhi, India.

F. G. Turner and J. Verhoogen, 1987. Igneous and Metamorphic Petrology, CBS Publisher and Distributors, New Delhi, India.

F. H. Hatch, A. K. Wells and M. K. Wells, 1984. Petrology of Igneous rocks, CBS Publishers and Distributors, New Delhi, India.

F. J. Pettijohn, 1984 (third edition). Sedimentary Rocks, CBS Publishers & Distributors, New Delhi, India.

H. G. F. Winkler, 1987. Petrogenesis of Metamorphic Rocks, Narosa Publishing House, New Delhi-Madras-Bombay, India.

J. D. Collinson and D. B. Thompson, 1989. Sedimentary structures, second edition. CBS Publishers & Distributors, Delhi

L. P. Paudel, 2011. Study of Minerals and Rocks in Thin Sections. GEOS, Kathmandu.

S. M. Rai, 2011. Study of Minerals and Rocks in Hand Specimens. Tara Rai, Kathmandu Nepal.

Sam Boggs, Jr., 1992. Petrology of sedimentary rocks. Macmillan Publishing Company, New York.

W. W. Moorehouse, 1959. Study of rocks in Thin Sections, CBS Publishers and Distributors, India.

Paleontology

David M. Raup and Steven M. Stanley, 1985 (2nd edition). Principles of paleontology. CBS Publishers and Distributors, Delhi, India.

E. N. K. Clarkson, 1979. Invertebrate Paleontology and Evolution, Harper and Row, New York.

H. L. Levin, 1999 (Sixth edition). The Earth through time. Saunder College Publishing.

Henry Woods, 1998 (8th Edition). Invertebrate. CBS Publishers and Distributors, Delhi, India.

Rabindra Kumar, 1992. Fundamentals of Historical Geology and stratigraphy of India. Wiley Eastern Ltd, New Delhi, India.

Shrock, R. Robert and Twenhofel, William, H., 1987 (second edition). Principle of Invertebrate Paleontology, CBS Publishers and Distributors, India.

Historical Geology

Don L. Eicher and A. Lee McAlester, 1980. History of the Earth, Prentice-Hall, Inc.New Jersey.

Rabindra Kumar, 1992. Fundamentals of Historical Geology and stratigraphy of India. Wiley Eastern Ltd, New Delhi, India.

Roy A. Lemon, 1990. Principles of Stratigraphy, Publisher: Aerill Publishing Co.

Sedimentology:

Don L. Eicher and A. Lee McAlester, 1980. History of the Earth, Prentice-Hall, Inc.New Jersey.

Donald R. Prothero and Fred Schwab, 1999. Sedimentary Geology - An introduction to sedimentary rocks and stratigraphy. W. H. Freeman and Company, New York.

Gerard M. Friedman and John E. Sanders, 1978. Principal of Sedimentology, John Wiley and Sons, New York.

H. E. Reineck. and I. B. Singh, 1973. Depositional Sedimentary Environments. Springer-Verlag, Berlin, New York.

M. R. Leeder, 1982. Sedimentology Process and Product, George Allen and Unmin, London.

Maurice E. Tucker, 1996. Sedimentary rocks in the field. John Wiley & Sons, New York.

N. K. Tamrakar, 2011. Practical Sedimentology. Bhrikuti Academic Publication. Kathmandu. Nepal

Publications of Journals of Nepal Geological Society.

Richard A. Devis Jr., 1983 Depositional System (A genetic approach to sedimentary geology). Prentice Hall Inc. Englewod Cliffs New Jersey.

Roy Lindholm, 1999. A practical approach to sedimentology. CBS Publishers & Distributors, Delhi.

S. M. Sengupta, 1994. Introduction to Sedimentology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.

B.Sc. II Year

Geology (GEO202)

Subject: Petrology, Paleontology and Historical Geology, and Sedimentology — Full marks: 50
Course No.: GEO202 — Pass marks: 20
Nature of course: Practical — Total period: 180

Petrology **60 hrs**

Lab 1: Systematic megascopic study of igneous rocks.

Lab 2: Systematic megascopic study of sedimentary rocks including textures and structures

Lab 3: Systematic megascopic study of metamorphic rocks.

Lab 4: Microscopic studies of igneous rocks.

Lab 5: Microscopic studies of sedimentary rocks.

Lab 6: Microscopic studies of metamorphic rocks.

Paleontology **48 hrs**

Lab 1: Study of Index fossils from Phylum Protozoa and Coelenterate

Lab 2: Study of Index fossils from Phylum Coelenterate

Lab 3: Study of Index fossils from Phylum Arthropoda

Lab 4: Study of Index fossils from Phylum Brachiopoda

Lab 5: Study of Index fossils from Phylum Polyzoa

Lab 6: Study of Index fossils from Phylum Mollusca (Class-Pelecypoda)

Lab 7: Study of Index fossils from Phylum Mollusca (Class Gastropoda)

Lab 8: Study of Index fossils from Phylum Mollusca (Class Cephalopoda).

Lab 9: Study of Index fossils from Phylum Echinodermata and Hemichordata.

Lab 10: Study of Vertebrate fossils.

Lab 11: Study of plant Index fossils through geologic time.

Historical Geology

14 hrs

Lab 1: Study of paleogeography, paleoecology and palaeoclimate of the Earth through geological time.

Lab 2: Study of paleotectonic (transgression and regression); Study of facies map their relation to sea level changes.

Lab 3: Preparation of columnar sections and their correlation (Litho and bio correlation).

Lab 4: Study of Geological Time Scale and Location of the Mountain orogengy, active volcanic area, convergent and divergent plate collision in the World Map

Sedimentology

58 hrs

Lab 14: Grain size analysis: Sieve analysis of sand and gravel, graphic presentation and interpretation of the data.

Lab 15: Grain size analysis: Pipette analysis of silt and clay, graphical presentation and interpretation of data.

Lab 16: Grain shape: Measurement of sphericity, form, roundness and surface features of detrital particles.

Lab 17: Description and interpretation of sedimentary structures: way up indicators, palaeocurrent indicators and deformation indicators.

Lab 18: Palaeocurrent analysis: Stereographic projection, correction of data for tectonic tilt, and construction of a rose diagram

Lab 19: Environmental models: Description and interpretation of facies and models of fluvial and lacustrine deposits.

Lab 20: Environmental models: Description and interpretation of facies and models of Deltaic and Tidal flat deposits.