Scheme and course structure for B.Sc. Geology effective from academic session 2015 and onwards

Course No.	Semester	Course Name	Credit		
			Total	Exam	Internal Assessment
GL-T1	**1st**	**Fundamentals of Geology**	100	80	20
GL-P1	**-**	**Field Work, Crystallography and Mineralogy**	50	25	25
GL-T2	**2nd**	**Petrology**	100	80	20
GL-P2	**-**	**Igneous & Metamorphic Petrology**	50	25	25
GL-T3	**3rd**	**Sedimentary and Economic Geology**	100	80	20
GL-P3	**-**	**Sedimentary Geology and ore study**	50	25	25
GL-T4	**4th**	**Geochemistry and Geophysics**	100	80	20
GL-P4		**Hydrogeology**	50	25	25
GL-T5	**5th**	**Structural Geology**	100	80	20
GL-P5	**-**	**Structural Geology**	50	25	25
GL-T6	**6th**	**Paleontology and Societal Remote Sensing**	100	80	20
GL-P6	**-**	**Remote Sensing and Palaeontology**	50	25	25

Note: GL=Geology, T=Theory, P=Practical

1st Semester

Course (GL-T1): Fundamentals of Geology

Unit-1

Introduction to the science of geology: Definition, branches, scope and importance, History of Geology; Modern theories about the origin of solar system; Evolution of continents and oceansRelation with other branches of sciences; Role of physics, chemistry and paleobiology in the development of ideas about earth. Role of Physics in crystallography, gravity, geomagnetism, isostasy, earthquakes and microscopy. Role of Chemistry in chemical bonds, crystal chemistry, solution chemistry, chemical energetics.

Unit-2

Introduction to rocks and minerals: Rocks as natural mineral aggregates; types of rocks: igneous rocks; sedimentary rocks; metamorphic rocks.

Preliminary knowledge about the most common rock forming and economic minerals

Physical properties and chemical composition of the earth and earthôs crust.

Geology as the history of Earth: How the rocks record history ï (a) Fossils (b) Mineralogy and thetexture; (c) Structures; (d) Palaeogeography, Paleoclimate. Surface relief of the earth. Exogenous and endogenous process.

Various Geospheres: Atmosphere; origin and evolution; structure, composition and energy balance; Heat budget; Ocean; origin and evolution; ocean circulation and its role in global climate;

Unit-3

Crystallography: Introduction to crystallography, geometrical nature of the order of crystals. Translation vectors, planar and space lattices. Normal class of crystal systems.

Morphology of crystals: Face, edge and solid angle, interfacial angle and Law of constancy of interfacial angles. Axial system and axial ratios. Parameter system of Weiss, Miller indices. Law of Rationality of indices.

Crystal growth and twining: Growth of crystals from solutions and from a melt under controlled conditions, crystal growth in open fractures, solution cavities and vesicles.

Twining in crystals: Types, causes and laws

Crystal forms: Crystallized, crystalline, cryptocrystalline and amorphous. Crystal habit: elongated, tabular, flattened and equant. Form of crystalline and cryptocrystalline aggregatesï types, examples and use in mineral identification.

Crystal chemistry: Dimorphism, polymorphism, pseudomorphism, isomorphism and solid solution.

Unit-4

Mineralogy: definition, scope and classification of silicate minerals and ore forming (oxide/ sulphide) minerals. Scalar and vector properties of minerals; Mohoôs scale of hardness.

Physical properties and the mode of occurrence of the following groups of minerals: Quartz, Feldspar, Mica, Amphibole, Pyroxene, Olivine, Garnet, Chlorite, and Carbonate.

Mineral optics: Elements of optics. Optics of isotopic medium ï refractive index, Snellôs law of critical angle, anisotropic media.

Polarization and interference of light.Polaroid, polarizing microscope- construction and use.Use of accessory plates.Pleochroism and Birefringence.

Optical indicatrix: isotropic, uniaxial and biaxial indicatrix.

Optical properties of minerals under plane-polarized and cross-polarized light: Forms, cleavage, fractures and parting, refractive index and relief, Becke line and its use.

Practical: GL-P1

Field Work: Study of landforms, erosional and depositional features. Handling of Clinometer and Brunton compass for Measuring dip and strike, and plotting of field data on toposheets.
Crystallography & Mineralogy: Demonstration of space lattice, model-Galena, Fluorite, Sphalerite, Pyrite and Calcite. Clinographic projection of the following crystals form: Cube, Octahedron, Zircon, Beryl, Calcite and Gypsum. Study of the physical properties of important rock-forming minerals as included in the theory paper.Study of optical properties of important rock forming minerals as included in the theory paper.Clinographic projections of the following crystals forms: Cube, Octahedron, Zircon Beryl, calcite and Gypsum.

Suggested Readings:
Holmes, A., 1996: Principles of Physical Geology, EUBS, Chapman.
Judson, S. and Kaufman, M. E., 1990: Physical Geology, Prentice Hall.
Press, F. and Seiver, R., 1989: The Earth, W. H. Freeman.
Terrly, G. W., 1958: Principles of Petrology, Mathuen.
Tarbuck, E. J. and Lutgens, F. K., 1997: Earth Science, Prentice Hall.
Lutgens, F. K. and Tarbuck, E. J., 1998: Essentials of Geology, Prentice Hall.
Gribble, D. D., 1988: Rutleyôs Elements of Mineralogy, DBS Publications.
Kerr, P. F., 1984. Optical Mineralogy.
Phillips, Wm, R. and Griffen, D.T., 1986: Optical Mineralogy. CBS Edition.
Putnis, A., 2001: Introduction to mineral Science. Cambridge University Press.Putnis, A., 1992: Introduction to mineral Science. Cambridge University Press.
Richard, V. G., 1997: Danaôs new Mineralogy. John Wiley.

2nd Semester

Course (GL-T2): Petrology

Unit-1
Nature and scope of petrology: Difference between Petrography and petrogenesis.
Texture and structure of igneous rocks: Large structures- blocky lava, amygdaloidal lava, and vesicular structures, pillow structures, flow structures, sheet and platy structures, prismatic and columnar structures. Crystallinity, granularity (phaneric and aphanitic), shapes of crystals, mutual relations of crystals, equigranular and unequigranular textures, porphyritic, poikilitic, opthitic, intersertal and intergranular textures, directive textures, intergrowth textures. Reaction textures. Reaction structures ï corona and kelyphitic borders.

Unit-2
Classification of igneous rocks: Principles of classification, CIPW classifications, IUGS classification and tabular classification. Nomenclature and description of common igneous rocks
Composition and constitution of magma: Definition of magma, composition of magma, types of magma, physico-chemical constitution of magma, primary magma.
Processes resulting in diversity in igneous rocks: Fractionation and differentiation ï Gravity settling, filter-press differentiation, flow diffusion and gaseous transfer within magma; liquid immiscibility, mixing of magmas. Assimilation.

Unit-3
Metamorphic rocks: Definition of metamorphism; Controls of metamorphism ï bulk composition and motivating forces in metamorphism- heat, pressure and chemically active fluids. Types of metamorphismï Contact, cataclastic, regional. Metasomatism, anataxis, palingenesis, migmatization.

Unit-4

Fundamental concepts. Catastrophism, uniformitarianism, cycle of erosion, and base level of erosion.
Weathering: definition and types, agents of weathering. Products of weathering.
Mass wasting: Definition, types, and factors affecting mass wasting-lithology, stratigraphy, structure, topography, climate, vegetation. Epeirogenesis and orogenesis.
Oceans: Topography of sea floor. ï Continental shelves, slope, abyssal plains, Ocean ridges and, submarine valleys, canyons, deep-sea trenches and guyots.
Oceanic erosion and deposition. Coral reefs: types fringing, barrier and atolls.
Volcanoes: types, distribution and eruptional features.
Glaciers: Definition and types, snowline, glacial movements and crevasses.
Geological work of glaciers: Erosion and deposition.
Aeolian processes: erosional and depositional features.
Geological work of river; erosional and depositional features. Drainage patterns
Karst topography: Surface and sub-surface features
Structural landforms: Definition and types, Inversion of topography.
Climate and landforms: humid, sub-humid, arid, semi-arid.
Soils: Soil formation, Soil profiles, Soil types of India.

Practical: GL-P2
Igneous & Metamorphic Petrology: Study in hand specimen and under microscope of the mineral composition, textures and structures of important igneous and metamorphic rocks as included in theory paper.

Suggested Readings:
Best, M. G., 1986: Igneous Petrology, CBS Pub.
Bose, M. K., 1997: Igneous Petrology. World Press.
Ehlers and Blatt, 1999: Petrology, (Igneous, Sedimentary and Metamorphic). CBS Pub.
Miyashiro, A., 1994: Metamorphic Petrology. UCL Press Ltd., London.
McBirney, A. R., 1993: Igneous Petrology. John Wiley.
Turner &Verhoogen, 1999: Igneous and Metamorphic Petrology. CBS Pub.
Tyrrell, G. W., 1987: Principles of Petrology.CBS Pub
Winter, J.D. 2010. Igneous and Metamorphic Petrology.
Yardley, B. W., 1989: An Introduction to Metamorphic Petrology. Longman, New York.

3rd Semester

Course (GL-T3): Sedimentary and Economic Geology

Unit-1
Sedimentary rocks: Processes involved in formation of sedimentary rocks: erosion, transportation, deposition, diagenesis and lithification.
Texture: size, roundness, sphericity. Surface texture, fabric, porosity and permeability. Grain size, grade scale, and methods of grain size analysis by sieving. Use of textural properties. Structure: primary, secondary and biogenic structures.
Major primary structure; cross bedding, cross lamination, horizontal bedding, graded bedding, sole marks, ripple marks, rain-imprints and dunes.
Classification of clastic and non-clasticsedimentary rocks: Rudaceous, Arenaceous, Argillaceous and calcareous,

Unit-2

Ore minerals and gangue.Concept of metallogenic Epochs and provinces. Classification of minerals deposits ï genetic and associational parameters.

Magmatic deposits; Hydrothermal deposits with reference to: a) Porphyry copper deposit b) Vein deposits of tin and tungsten.

Formation of pegmatite and pegmatite deposits in India

Oceanic mineral resources (manganese nodules).

Ores formed by metamorphic processes. Supergene enrichment deposits.

Placer & residual deposits.

Unit-3

Mode of occurrence of following minerals deposits in India: Banded iron formation, Gold, Thorium, Mica, Bauxite and Tungsten deposits.

Origin of Petroleum ï Organic versus inorganic theories, transformation of organic matter into petroleum (geochemical aspects, pressure, temperature, depth of occurrence). Limiting conditions of petroleum occurrence.

Unit-4

Reservoir rocks ï definition and types. Source rocks; definition and types.

Migration and accumulation of petroleum: primary and secondary migration.

Reservoir Traps, classification (structural, stratigraphic); Cap rocks ï types.

Coal; Introduction; Constituents of coal: Rank and grade of coal; Varieties of coal (physical and chemical characters); Origin of coal. Distribution of Coal in time and space.

Practical: GL-P3

Sedimentary Geology and ore study: Study in hand specimen and under microscope of the mineral composition, textures and structures of important sedimentary rocks as included in theory paper.

Megascopic study of ore minerals of cu, Fe, Al, Mn, Pb and Zn. Precious and semi-precious stones-diamond, ruby, sapphire, emerald, opal, jasper, agate and garnet.

Suggested Readings:

Aguado, E., and Burt, J., 2009. Understanding weather and climate. Prentice Hall.

Collinson, J. D, 1999: Sedimentary Structures. Springer Verlag.

Lutgens, Tarbuck & Tasa 2009. The Atmosphere: An Introduction to Meterology. Pearson Pub.

Miall, A. D., 1999: Principles of Sedimentary Basin Analysis. Springer-Verlag.

Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: Sand and Sandstone. Springer Verlag.

Reading, J. G. 1996: Sedimentary Environment and Facies. Black well.

Rohli, R.Y., and Vega, A.l., 2007. Climatology. Jones and Barlatt

Ruddiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher. .

Selley, R. C., 1976: Introduction of Sedimentology. Academic Press, London.

Sengupta, S., 1997: Introduction to Sedimentology. Oxford-IBH.

4th Semester

Course (GL-T4): Geochemistryand Geophysics

Unit-1

Introduction to geochemistry: Crystal chemistry-chemical bonds, coordination number, radius ratio, ionization potential, electro-negativity, atomic substitution, phase rule. Cosmic abundance of elements. Major element, trace elements and Rare earth elements, Large ion lithophile elements and High field strength elements. Partition Coefficient

Gold Schmidtôs geochemical classification of elements. Geochemical characteristics of crust, mantle and core
Geochronology and age of Earth.Relative and absolute dating techniques for age determination.Radioactivity and concept of half-life, decay constant, natural radioactive isotopes.

Unit-2
Introduction and scope of geophysics, Spheroidal shape of earth and Geoid, magnetic field of the earth, paleomagnetism, Exploring Earth's interior with geophysical techniques.
Applications of geophysics in mineral and energy resources exploration.
Earth's thermal history: Heat conduction and heat flow. Thermal gradient of the earth.Convection currents-evidence and models.
Gravitational Field: Concept, its variability with latitude, altitude, topography, and subsurface density variations. Gravity instruments: Pendulum gravimeters, Ship borne measurements
Units of gravity, gravity anomaly - definition, types (Free- air, Bouguer), local and regional concepts.Detection of cavities at engineering sites.
Isostasy: Observation; Pratt and Airy schemes of the isostatic compensation, elastic crust on viscous mantle.

Unit-3
Seismology: Earthquake and Seismic waves, effects of seismic waves and damage to structures and natural objects. Basic features of seismographs; Magnitude and intensity of an earthquake
Types of earthquakes: tectonic and volcanic. Induced seismicity, Neotectonics. Elastic rebound theory - statement and geodetic evidence.
Earthquake location: Focus, epicenter and hypocenter; Earthquake belts; Focal depth of earthquakes. Earthquake focal mechanisms - how these are obtained.
Seismic wave reflection and refraction. Structure of the Earth: Crust, mantle; Outer core, inner core; wave speed and density distribution.
Earthquake Prediction: Need, definition, possibility, results; Seismic gap theory.

Unit-4
Distinction between Hydrology, Geohydrology and hydrogeology;
Occurrence of groundwater, water table, aquifer and its types (unconfined, confined and perched).
Hydrological properties of rocksï porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, and storativity.Hydrological classification of geological formations. Darcyôs law
Hydrological cycle and its components. Water quality parameters and standards for drinking purposes. Fundamentals of groundwater exploration ï geological and geophysical methods. Water resources of J&K.

Practical: GL-P4
Hydrogeology: Delineations of hydrological boundaries on water table contour maps and estimation of aquifer properties as hydraulic conductivity. Storage coefficient and Transmissivity.

5th Semester

Course (GL-T5): Structural Geology

Unit-1
Basic concepts of field geology: Mapsï definition, topographic and geological maps.
Dip and strike of stratified rocks, True dip, apparent dip, plunge and pitch of linear structures. Outcrop patterns. True thickness and vertical thickness. Width of the outcrop, relation between true thickness and the width of outcrop.

Criteria for distinction between normal and overturned sequences: ripple marks, cross bedding, graded bedding, mud cracks, rain-imprints, Pillow lava, vesicular tops of lava beds, Relationship of cleavage with bedding, Paleontological methods.
Mechanical principles:
Stress; definition of force and stress.Normal and shear stress.Basic concept of stress ellipse. Strain definition and computation of changes in line length. Basic concept of strain ellipse.

Unit-2
Folds: Definition and classification (geometrical);fold parameters/components
Unconformities: Definition, types of unconformities. Criteria for recognition of unconformities.
Concordant pluton: sills, laccoliths, lopoliths, and phacoliths. Discordant pluton: dykes, volcanic vents, ring dykes.
Joints- Morphology and classification (Geometrical).
Foliation: Definition and classification; Schistosity, gneissosity, slaty cleavage
Lineation: Definition and classification, slickenside, mineral lineation Cleavage/ bedding intersections, pucker lineation, boudinage, quartz roding and mullion.

Unit-3
Faults: Definition, terminology and classification (geometrical)
Criteria for recognition of faults: discontinuity of structures, repetition and omission of strata, features characteristic of fault plane: slickenside, gouge, fault breccias, mylonites, silicification and mineralization, differences in sedimentary facies. Physiographic criteria: scraps, triangular facets. Offset streams.
Important concepts about Earth dynamics: outline description of Contraction, Expansion, Plate tectonic models. Plate tectonics - basic concepts and definitions, types of plate margins, important characters of plate margins.

Unit-4
Mechanism of plate movement; Mantle plumes vis-à-vis island chains.
Plate tectonics in relation to the distribution of seismic, volcanic and island arc belts.
Plate tectonic models for the origin of mountain belts: Ocean-ocean, ocean-continent, Continent-Continent types of convergent boundaries
Tectonics of the Indian subcontinent: Tectonic divisions (Extra-peninsula; Indo- Gangetic Plain and Peninsular Shield), their tectonic characters and major structural trends.
Northward movement of the Indian Plate and the origin and evolution of the Himalayas and its thrust belts.
Tectonic models for the origin and evolution of the Indo-Gangetic plain. Seismicity of the Indian subcontinent

Practical: GL-P5
Structural Geology: Study of contours and landforms; Strike, true dip and Apparent dip problems; Measurement of thickness and width of outcrops; Completion of outcrops in geological maps; and drawing of profiles and study of geological maps.

Suggested Readings:
Gunter, F., 1991: Principles and Applications of Inorganic Geochemistry, Prentice Hall.
Albarede, F., 2003: Geochemistry - An Introduction, Cambridge.
Marshal, C. P. &Fairbridge, R. W., 1999: Encyclopaedia of Geochemistry, Kluwer Acadmic.
William, L., 1998: Introduction to Geophysics, Cambridge.
Todd, D. K., 1980: Groundwater Hydrology, John Wiley.
Karanth, K. R., 1987: Groundwater assessment, Development and Management, MG. Hill.

6th Semester

Course (GL-T6): Paleontology and Societal Remote Sensing

Unit-1

Paleontology: Origin and evolution of the life through ages; Geological time scale; Preliminary idea about faunal succession. Fossils, their characters, conditions necessary for fossilization; types of preservation and occurrence.Application of Paleontology.

Morphology, geological, geographical and stratigraphic distribution of the following: (1) Brachiopoda (2) Bivalvia (3) Gastropoda (4) Cephalopoda (5) Graptoloida (6) Anthozoa (7) Echinoidea (8) Trilobita

Unit-1

Elementary ideas about Foraminifera, Ostracoda, Radiolarian and Conodonts.
Elementary concept of vertebrate Paleontology with special reference to Siwaliks.
Evolution of Man, Horse & Elephant
Introduction to micropaleontology and microfossils and their application.
Introduction to Palaeobotany with special reference to Gondwana plant fossils.
Extinction of organisms with special reference different hypothesis for the extinction of dinosaurs
Introduction to Palynology and its applications.Application of Paleontological data in paleogeographic reconstructions.Paleontological evidence in favor of continental drift.

Unit-3

Remote sensing: Concept and foundation of RS (Electromagnetic spectrum, radiation laws). Overview of RS technology. Landsat, IRS,SPOT, MODIS
Interaction of Electromagnetic waves with Earth surface features (water, soil, rocks, and vegetation). Photo-geology and its applications.
Application of remote sensing: geomorphological mapping, geological hazards assessment, hydrology and land use/land cover mapping.
Introduction to GIS and its applications.
Fundamental concept (environment, population needs and planning.
Mineral resources vis-à-vis population needs; environmental impact of exploration and processing of mineral resources on air, soil and surface and subsurface water.
Water supply and water use - human, agriculture and industrial.
Societal implications of major hydroelectric, nuclear and industrial projects.
Natural Hazards:
Earthquakes; Scale of intensity related damage, preventive measures.
Landslides: Slope stability, causes of landslides, anthropogenic activity and landslides, prevention and correction of landslides.
Floods: magnitude and frequency of floods, urbanization and flooding, nature and extent of flood hazard.
Coastal hazards: tropical cyclones, tsunamis and coastalerosion

Unit-4

Stratigraphy: introduction, nomenclature and Principles. Stratigraphic correlation; imperfection of geological record. Brief introduction to Precambrian rocks of India with special reference to their classification, distribution, lithology and economic importance: Dharwar, Aravalli, Cuddapah, Vindhyan and J&K
Stratigraphy of the following Phanerozoic rocks with special reference to their lithology and fossil content: Paleozoic succession of Kashmir. Triassic of Spiti, Jurassic of Kuch, Cretaceous of Tiruchirapalli.Stratigraphy of Siwaliks and Karewas of Kashmir.

Practical: GL-P6

Remote Sensing and Palaeontology: Image subset, Landuse and landcover mapping, image geo-referencing.

Study of morphological characters of the selected genera- Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, Trilobita, Echinoidea, Graptoloidea and Anthozoa.

Suggested Readings:

Condie, K. C., 1997: Plate Tectonics and Crustal Evolution, Butterworth &Heimnemann.
Keary, P. and Vine, F. J., 2000: Global Tectonics, Blackwell Science.
Cox, A., 1996: Plate Tectonics. Blackwell Science.
Meyerhoff, et al., 1996: Surge Tectonics, Kluwer Academics.
Bell, F. G., 1998: Environmental Geology, Blackwell.
Bell, F. G., 1999: Geological Hazards, Routledge, London.
Subramanian, V., 2001: Text Book on Environmental Science, Narosa International.