

CBCS Syllabus for
Department of Geology
Nagaland University

Honours and Pass courses
(BSc in Geology)

2022

NAGALAND UNIVERSITY
DEPARTMENT OF GEOLOGY
Syllabus for B.Sc. Honours in Geology
Three Years (Six Semesters) Course
Under Choice Based Credit System - 2022

Semester-wise Course Distribution*

YEAR	Semester	Core Course (14)	Ability Enhancement Course (2)	Skill Enhancement Course (2)	Discipline Specific Elective (4)	Generic Elective (4)
1 ST Year	I	i) EARTH SYSTEM SCIENCE ii) STRUCTURAL GEOLOGY	AEC- 1 COMMUNICATIVE ENGLISH			GE-1
	II	iii) ELEMENTS OF GEOCHEMISTRY iv) MINERAL SCIENCE	AEC- 2 ENVIRONMENTAL SCIENCE			GE-2
2 ND Year	III	v) IGNEOUS PETROLOGY vi) SEDIMENTARY PETROLOGY vii) METAMORPHIC PETROLOGY		SEC-I (Geological Field Work-I)		GE-3
	IV	viii) PALEONTOLOGY ix) STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY x) HYDROGEOLOGY		SEC-II (Geological Field Work-II)		GE-4
3 RD Year	V	xi) ECONOMIC GEOLOGY xii) GEOMORPHOLOGY			DSE-1 DSE-2	
	VI	xiii) ENGINEERING GEOLOGY xiv) REMOTE SENSING AND GIS			DSE-3 DSE-4	

*Modalities of Examination will be prepared by the Examination Section, Nagaland University as per NEP 2020 Guidelines.

Semester-wise Marks Distribution (Total of Credits in the Six Semesters = 140)

Semester	Course Code	Course Name	Marks	Credit	Contact Hours
I	GEOL-101	Earth System Science	100	4	60
	GEOL-102	Practical on Earth System Science	50	2	30
	GEOL-103	Structural Geology	100	4	60
	GEOL-104	Practical on Structural Geology	50	2	30
	GEOL (GE)-105	(i) Essentials of Geology or (ii) Earth surface processes	100	4	60
	GEOL(GE)-106 (Corresponding one)	(i) Practical on Essentials of Geology (ii) Practical on Earth surface processes	50	2	30
	AEC-1	Communicative English	50	2	30
		Total	500	20	300
II	GEOL-201	Elements of Geochemistry	100	4	60
	GEOL-202	Practical on Elements of Geochemistry	50	2	30
	GEOL-203	Mineral Science	100	4	60
	GEOL-204	Practical on Mineral Science	50	2	30
	GEOL(GE)-205	(i) Rocks and Minerals or (ii) Soils: Present and past	100	4	60
	GEOL(GE)-206 (Corresponding one)	(i) Practical on Rocks and Minerals (ii) Practical on Soils: Present and past	50	2	30
	AEC-2	Environmental Science	50	2	30
		Total	500	20	300
III	GEOL-301	Igneous Petrology	100	4	60
	GEOL-302	Practical on Igneous Petrology	50	2	30
	GEOL-303	Sedimentary Petrology	100	4	60
	GEOL-304	Practical on Sedimentary Petrology	50	2	30
	GEOL-305	Metamorphic Petrology	100	4	60
	GEOL-306	Practical on Metamorphic Petrology	50	2	30
	GEOL(GE)-307	(i) Fossils and their Applications or (ii) Earth Resources	100	4	60
	GEOL(GE)-308 (Corresponding one)	(i) Practical on Fossils and their Applications (ii) Practical on Earth Resources	50	2	30
	GEOL(SEC)-309	Field Work-I: Basic Geological Field Training	50	2	60
		Total	650	26	420
IV	GEOL-401	Palaeontology	100	4	60
	GEOL-402	Practical on Palaeontology	50	2	30
	GEOL-403	Stratigraphic Principles and Indian Stratigraphy	100	4	60
	GEOL-404	Practical on Stratigraphic Principles and Indian Stratigraphy	50	2	30
	GEOL-405	Hydrogeology	100	4	60

	GEOL-406	Practical on Hydrogeology	50	2	30
	GEOL(GE)-407	(i) Natural Hazards and Disaster or Management (ii) Nuclear Waste management	100	4	60
	GEOL(GE)-408 (Corresponding one)	(i) Practical on Natural Hazards and Disaster management (ii) Practical on Nuclear Waste Management	50	2	30
	GEOL(SEC)-409	Geological Field Work-II: Precambrian Geology/Tertiary Geology/ Economic Geology	50	2	60
		Total	650	26	420
V	GEOL-501	Economic Geology	100	4	60
	GEOL-502	Practical on Economic Geology	50	2	30
	GEOL-503	Geomorphology	100	4	60
	GEOL-504	Practical on Geomorphology	50	2	30
	GEOL(DSE)-505	(i) Exploration Geology or (ii) Evolution of life through time	100	4	60
	DSE(GEOL)-506 (Corresponding one)	(i) Practical on Exploration Geology (ii) Practical on Evolution of life through time	50	2	30
	GEOL(DSE)-507	(i) Geology of Nagaland or (ii) Introduction to Geophysics	100	4	60
	GEOL(DSE)-508 (Corresponding one)	(i) Practical on Geology of Nagaland (ii) Practical on Introduction to Geophysics	50	2	30
		Total	600	24	360
VI	GEOL-601	Engineering Geology	100	4	60
	GEOL-602	Practical on Engineering Geology	50	2	30
	GEOL-603	Remote Sensing and GIS	100	4	60
	GEOL-604	Practical on Remote Sensing and GIS	50	2	30
	GEOL(DSE)-605	(i) Environmental Geology or (ii) Urban Geology	100	4	60
	GEOL(DSE)-606 (Corresponding one)	(i) Practical on Environmental Geology (ii) Practical on Urban Geology	50	2	30
	GEOL(DSE)-607 (Any one)	(i) Fuel Geology (ii) Earth and Climate (iii) River Science	100	4	60
	GEOL(DSE)-608 (Corresponding one)	(i) Practical on Fuel Geology (ii) Practical on Earth and Climate (iii) Practical on River Science	50	2	30
		Total	600	24	360

B. Sc. (Hons.) Three Years (Six Semesters) Course
Under **Choice Based Credit System**
CORE COURSE: GEOLOGY

Course Code: GEOL -101

Course Name: Earth System Sciences

Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1: Introduction to various branches of Geology. General characteristics and origin of the Universe. The terrestrial and jovian planets. Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age. Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere. Convection in Earth's core and production of its magnetic field.

Unit 2: Concept of plate tectonics, sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts, Volcanoes-types, products and their distribution.

Unit 3: Oceanic current system and effect of Coriolis force, Concepts of eustasy, Land-air-sea interaction. Wave erosion and beach processes. Atmospheric circulation, weather and climatic changes. Earth's heat budget. Soils- processes of formation, soil profile and soil types.

Unit 4: Nature of stratigraphic records. Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods and their application in geological studies. History of development in the concepts of uniformitarianism, catastrophism and neptunism. Laws of superposition and faunal succession. Introduction to geomorphology of Indian subcontinent.

Unit 5: Distribution of elements in solar system and in Earth. Chemical differentiation and composition of the Earth. General concepts about geochemical cycles and mass balance. Geochemical behaviour of major elements. Mass conservation of elements and isotopic fractionation.

Course Code: GEOL -102

Course Name: Practical on Earth System Sciences

Credit: 2; Full Marks – 50, Pass Marks-20

Study of major geomorphic features and their relationships with outcrops through physiographic models. Study of soil profile of any specific area. Study of distribution of major lithostratigraphic units on the map of India. Study of major ocean currents of the world. Study of seismic profile of a specific area and its interpretation

Suggested readings:

- Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
- Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
- Gross, M. G. (1977). Oceanography: A view of the earth.

Course Code: GEOL -103

Course Name: Structural Geology

Credit: 4; Full Marks – 100, Pass Marks - 40

Unit 1: Effects of topography on structural features, topographic and structural maps, important representative factors of the map. Techniques in structural geology.

Unit 2: Concept of rock deformation: Stress and Strain in rocks and their geological significance, Planar and linear structures; dip and strike; Outcrop patterns of different structures.

Unit 3: Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding.

Unit 4: Description and origin of foliations: axial plane cleavage and its tectonic significance. Description and origin of lineation and relationship with the major structures.

Unit 5: Geometric and genetic classification of Joints and faults. Effects of faulting on the outcrops, Criteria for recognition of faults.

Course Code: GEOL-104

Course Name: Practical on Structural Geology

Credit: 2; Full Marks – 50, Pass Marks-20

Basic idea of topographic contours, Topographic sheets of various scales. Introduction to Geological maps: Lithological and Structural maps. Structural contouring and 3-point problems of dip and strike. Drawing profile sections and interpretation of geological maps of different complexities Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.).

Suggested readings:

- Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
- Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley.
- Lahee F. H. (1962) Field Geology. McGraw Hill.
- Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.
- Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
- Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical).

Course code: GEOL -201

Course Name: Elements of Geochemistry

Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1: Introduction to properties of elements: The periodic table. Chemical bonding, states of matter and concept of major, minor and trace elements. Geochemical classification of elements.

Unit 2: Composition of different Earth reservoirs and the nuclides and radioactivity. Conservation of mass, isotopic and elemental fractionation. Concept of radiogenic isotopes in geochronology and isotopic tracers.

Unit 3: Advection and diffusion. Chromatography. Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations. Elements of marine chemistry. Mineral reactions- diagenesis and hydrothermal reactions.

Unit 4: The solid Earth – geochemical variability of magma and its products. The Earth in the solar system. Composition of the bulk silicate Earth. Meteorites.

Unit 5: Geochemical behaviour of the following elements: Si, Al, Fe, Ca, K, Na and Mg.

Course Code: GEOL-202

Course Name: Practical on Elements of Geochemistry

Credit: 2; Full Marks – 50, Pass Marks- 20

Types of geochemical data analysis and interpretation of common geochemical plots. Geochemical analysis of geological materials. Geochemical variation diagrams and its interpretations.

Suggested Readings:

- Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
- Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications, Wiley India Pvt. Ltd.
- Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
- Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
- Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers.

Course Code: GEOL-203

Course Name: Mineral Science

Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1: Elementary ideas about crystal morphology in relation to internal structures. Crystal parameters and indices. Crystal symmetry and common crystal forms- dome, prism, pyramid and pinacoid.

Unit 2: Study of normal classes of the Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems. Classification of 32 point groups.

Unit 3: Mineral – definition, classification and physical properties. Isomorphism, polymorphism and pseudomorphism. Silicate structures. Cubic close packing and hexagonal close packing.

Unit 4: Study of common rock-forming minerals – quartz, feldspar, pyroxene, amphibole, mica, aluminosilicate, garnet and olivine groups.

Unit 5: Introduction to the petrological microscope. Nature of light: Isotropic and anisotropic substances, ordinary and polarised light, refractive index, birefringence, pleochroism, twinkling, interference colour, extinction and twinning.

Course Code: GEOL -204

Course Name: Practical on Mineral Science

Credit: 2, Full Marks – 50, Pass Marks-20

Observation and documentation of symmetry elements of important crystal models of cubic, tetragonal, orthorhombic, monoclinic, triclinic and hexagonal crystal systems.

Study of physical properties of minerals in hand specimens-Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Topaz, Augite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Sodalite, Zeolite and Talc.

Non-silicates: Native Metals, Graphite, Gypsum, Calcite, Fluorite, Barite, Apatite, Corundum and Pyrite.

Study of some important silicate and non-silicate minerals under petrological microscope and their characteristic properties.

Suggested Readings:

- Deer, W. A., Howie, R. A. and Zussman, J. (1992). An introduction to the rock-forming minerals. London; Longman.
- Kerr, P. F. (1959). Optical Mineralogy. McGraw- Hill.
- Klein, C., Dutrow, B., Dwight, J.: The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
- Verma, P. K. (2010). Optical Mineralogy. Ane Books Pvt Ltd.

Course Code: GEOL -301

Course Name: Igneous Petrology

Credit: 4; Full Marks– 100, Pass Marks - 40

Unit 1: Introduction to Igneous petrology: Heat flow, geothermal gradients through time, origin and nature of magma, magmatic differentiation and assimilation.

Unit 2:

Classification of igneous rocks: mineralogical and chemical classification, Textures and structures of igneous rocks, Mode of occurrence of Igneous rocks.

Unit 3:

Phase diagrams and petrogenesis. Unary, Binary (forsterite-silica and albite-anorthite) and Ternary (diopside-albite-anorthite and orthoclase-albite-silica) Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic magmas. Magma generation in crust and mantle, their emplacement and evolution.

Unit 4:

Magmatism in different tectonic settings. Magmatism in the oceanic domains (MORB, OIB).Magmatism along the plate margins (Island arcs/continental arcs)

Unit 5:

Petrogenesis of Felsic, Mafic and Ultramafic igneous rocks: granite, pegmatite, syenite, gabbro, basalt, komatiite, peridotite, pyroxenite.

Course Code: GEOL -302

Course Name: Practical on Igneous Petrology

Credit: 2; Full Marks – 50, Pass Marks-20

Study of important igneous rocks in hand specimens and thin sections- granite, pegmatite, syenite, diorite, gabbro, anorthosite, peridotite, pyroxenite, basalt, andesite, trachyte, rhyolite, dacite. Modal analysis and Niggli value calculations of important igneous rocks.

Suggested readings:

- Bose M.K. (1997). Igneous Petrology.
- Cox, K.G., & Bell, J.D. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
- McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press).
- Myron G. Best (2001). Igneous and Metamorphic Petrology,
- Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
- Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
- Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
- Tyrrell, G.W. (1926). Principles of Petrology. Springer.
- Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.

Course Code: GEOL-303
Course Name: Sedimentary Petrology
Credit: 4;
Full Marks – 100, Pass Marks– 40

Unit 1:

Physical and chemical weathering and origin of sediments, their transportation (laminar and turbulent flow) and deposition. Tectonic control on sediment generation.

Unit 2:

Classification of sedimentary rocks: clastic and non-clastic. Textures in sedimentary rock: Grain size scale, particle size distribution, particle shape and fabric.

Unit 3:

Sedimentary structures: Ripple marks, cross beds, mud-cracks, graded bedding, flute marks, loadcast, tracks, trails and related structures. Paleocurrent analysis.

Unit 4:

Siliciclastic rocks: Conglomerates, sandstones, mudrocks. Carbonate rocks: limestone and its classification, dolomite and dolomitisation.

Unit 5:

Diagenesis: Concepts and stages of diagenesis. Compaction, cementation and authigenesis/ neomorphism. Soils and paleosols.

Course Code: GEOL-304
Course Name: Practical on Sedimentary Petrology
Credit: 2;
Full Marks – 50, Pass Marks-20

Exercises on sedimentary structures. Particle size distribution and statistical treatment. Paleocurrent analysis. Petrography of clastic and non-clastic rocks through hand specimens and thin sections.

Suggested readings:

- Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
- Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell.
- Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
- Tucker, M. E. (2006) Sedimentary Petrology, Blackwell Publishing.

Course Code: GEOL-305
Course Name: Metamorphic Petrology
Credit: 4;
Full Marks – 100, Pass Marks - 40

Unit 1:

Metamorphism: Definition of metamorphism. Factors controlling metamorphism. Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism.

Unit 2:

Metamorphic facies and grades: Index minerals, Concept of metamorphic facies and grade, Chemographic projections, Mineralogical phase rule, Structure and textures of metamorphic rocks.

Unit 3:

Metamorphism and Tectonism: Relationship between metamorphism and deformation. Prograde and retrograde metamorphism.

Unit 4:

Brief idea of anatexis and origin of migmatites. Metasomatism and role of fluids in metamorphism. Ocean floor metamorphism

Unit 5:

Petrological study of the following metamorphic rocks- schist, gneiss, khondalite, charnockite, slate, quartzite and marble.

Course Code: GEOL-306
Course Name: Practical on Metamorphic Petrology
Credit: 2
Full Marks – 50, Pass Marks-20

Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks:

Low grade metamorphic rocks: serpentinite, schist, slate.

Medium to high grade metamorphic rocks: Gneiss, amphibolite, garnetiferous schist, sillimanite-kyanite-bearing rocks, granulite, eclogite, marble.

Laboratory exercises in graphic plots for petrochemistry and interpretation of assemblages.

Suggested readings:

- Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
- Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
- Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
- Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
- Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

Course Code: GEOL-401
Course Name: Palaeontology
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1:

Fossilization and fossil record: Nature and importance of fossil record; Fossilization processes and modes of preservation, Introduction to Palaeobotany, Gondwana Flora and Ichnology.

Unit 2:

Species concept with special reference to palaeontology, Taxonomic hierarchy. Theory of organic evolution interpreted from fossil record. Growth strategies.

Unit 3:

Brief introduction to important invertebrate groups (bivalvia, gastropoda, brachiopoda and echinoidea) and their biostratigraphic significance. Significance of ammonites in Mesozoic biostratigraphy. Functional adaptation in trilobites and ammonoids.

Unit 4:

Mesozoic reptiles with special reference to origin, diversity and extinction of dinosaurs. Evolution of horse and intercontinental migrations. Human evolution.

Unit 5:

Application of Fossils in stratigraphy: Biozones, index fossils and correlation. Fossils and paleoenvironmental analysis. Application of palaeontology in paleoecology.

Course Code: GEOL -402
Course Name: Practical on Palaeontology
Credit: 2
Full Marks – 50, Pass Marks-20

Study of fossils showing various modes of preservation. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.

Suggested readings:

- Brasier, M.D. (2005) Microfossils. Blackwell Publishing.
- Benton, M. (2009). Vertebrate palaeontology. John Wiley & Sons.
- Clarkson, E. N. K. (2012) Invertebrate palaeontology and evolution 4thEdition by BlackwellPublishing.
- Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Palaeontology.
- Shukla, A. C. And Misra, S. P. (1975). Essentials of palaeobotany. Vikas Publisher.

Course Code: GEOL -403

Course Name: Stratigraphic Principles and Indian Stratigraphy

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Concept of facies in stratigraphy. Walther's law of facies. Concepts of litho-, bio- and chrono-stratigraphy. Dynamic stratigraphy: chemostratigraphy, seismic stratigraphy, sequence stratigraphy. Magnetostratigraphy.

Unit 2:

International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of stratotypes. Global stratotype section and point (GSSP). Concept of paleogeographic reconstruction.

Unit 3:

Brief introduction to tectonic and physiographic subdivisions of India. Introduction to Indian Shield. Introduction to Proterozoic basins of India: Geology of Vindhyan and Cudappah basins.

Unit 4:

Palaeozoic succession of Kashmir and its correlatives from Spiti and Zaskar Stratigraphy. Mesozoic stratigraphy of India: Triassic successions of Spiti, Jurassic of Kutch, Cretaceous of Trichinopoly. Cenozoic stratigraphy of Assam.

Unit 5:

Important Stratigraphic boundaries in India: Precambrian-Cambrian boundary, Permian-Triassic boundary and Cretaceous-Tertiary boundary. Volcanic provinces of India: Deccan, Rajmahal and Sylhet Trap.

Course Code: GEOL-404

Course Name: Practical on Stratigraphic Principles and Indian Stratigraphy

Credit: 2

Full Marks – 50, Pass Marks-20

Study of geological map of India and identification of major stratigraphic units. Study of rocks in hand specimens from known Indian stratigraphic horizons. Drawing various paleogeographic maps of Precambrian time. Study of different Proterozoic supercontinent reconstructions.

Suggested readings:

- Doyle, P. & Bennett, M. R. (1996). Unlocking the Stratigraphic Record. John Wiley.
- Krishnan, M. S. (1982). Geology of India and Burma, CBS Publishers, Delhi.
- Ramakrishnan, M. & Vaidyanadhan, R. (2008). Geology of India Vol. 1 & 2, Geological Society of India, Bangalore.
- Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.
- Ravindra Kuman (1986). Fundamentals of Historical Geology and Stratigraphy of India.

Course Code: GEOL-405

Course Name: Hydrogeology

Credit: 4

Full Marks– 100, Pass Marks– 40

Unit 1:

Scope of hydrogeology. Hydrologic cycle: precipitation, evapotranspiration, run-off, infiltration and subsurface movement of water. Origin of groundwater. Vertical distribution of subsurface water. Rock properties affecting groundwater; aquifer parameters. Types of aquifer.

Unit 2:

Darcy's law and its validity; intrinsic permeability and hydraulic conductivity; laminar and turbulent groundwater flow. Determination of hydraulic conductivity in the laboratory and field. Groundwater table contour maps. Water level fluctuations.

Unit 3:

Basic concepts of well hydraulics and groundwater exploration. Surface-based groundwater exploration methods. Introduction to subsurface borehole logging methods.

Unit 4:

Physical and chemical properties of water and water quality. Introduction to methods of interpreting groundwater quality data using standard graphical plots. Conjunctive and consumptive uses of surface and ground water. Sea water intrusion in coastal aquifers.

Unit 5:

Surface and subsurface water interaction. Basic concepts of water balance studies. Groundwater pollution. Issues related to groundwater resources development and management. Rainwater harvesting.

Course Code: GEOL-406

Course Name: Practical on Hydrogeology

Credit: 2

Full Marks – 50, Pass Marks-20

Preparation and interpretation of water level contour maps and depth to water level maps. Study, preparation and analysis of hydrographs for differing groundwater conditions. Water potential zones of India (map study). Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams). Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

Suggested readings:

- Davis, S.N. and De Weist, R.J.M. (1966) Hydrogeology, John Wiley & Sons Inc., N.Y.
- Karanth K.R. (1987) Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
- Todd, D. K. (2006) Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Course Code: GEOL -501
Course Name: Economic Geology
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1

Ore and gangue minerals, tenor. Resources and reserves. Classification of Economic minerals: metallic and non-metallic. Metallogenic Provinces and Epochs. Textures and structures of ores.

Unit 2:

Processes of formation of ore deposits: Magmatic, hydrothermal, metamorphic, sedimentary, residual and mechanical concentration; oxidation and supergene enrichment.

Unit 3:

Chemical composition, occurrence, origin, uses and distribution of the following economic mineral deposits in India: iron, manganese, chromium, copper, aluminium, lead & zinc and gold.

Unit 4:

Chemical composition, occurrence, origin, uses and distribution of the following industrial mineral deposits in India: magnesite, graphite, mica, asbestos, sillimanite and kyanite.

Unit 5:

Brief account on the following economic deposits in the North East India: coal, petroleum, limestone, chromite and uranium. Introduction to gemstones.

Course Code: GEOL -502
Course Name: Practical on Economic Geology
Credit: 2
Full Marks – 50, Pass Marks-20

Megascopic identification of ores. Study of microscopic properties of ore forming minerals (Oxides and sulphides). Distribution of important ores and other economic minerals in India.

Suggested readings:

- Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
- Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
- Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley.
- Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
- Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
- Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
- Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

Course Code: GEOL-503

Course Name: Geomorphology

Credit: 4

Full Marks – 100, Pass Marks - 40

Unit 1:

Introduction to Geomorphology, Historical development of geomorphological concepts and scales in geomorphology. Endogenic and exogenic processes- diastrophism, orogenesis, degradational, aggradational and anthropogenic processes.

Unit 2:

Geoid, topography, hypsometry. Topography of ocean basins and mountain ranges (with emphasis on Himalaya). Concept of plate tectonics.

Unit 3:

Surficial processes, weathering and erosion. Glacial, periglacial, fluvial, coastal and eolian processes and associated landforms. Landforms associated with igneous activity.

Unit 4:

Rates of uplift and denudation. Tectonics and drainage development. Sea-level changes. Long-term landscape development.

Unit 5:

Overview of Indian Geomorphology: Northern mountains, the Great Plains, Central Highlands, Peninsular Plateau, Coastal Plains and the Islands. Extraterrestrial landforms. Hill slopes. Surface processes and natural hazards.

Course Code: GEOL-504

Course Name: Practical on Geomorphology

Credit: 2

Full Marks – 50, Pass Marks-20

Reading topographic maps. Concept of scale in preparation of a topographic profile. Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index. Morphometry of a drainage basin. Calculating different morphometric parameters. Preparation of geomorphic map, Interpretation of geomorphic processes from the geomorphology of the area.

Suggested readings:

- Robert S. Anderson and Suzanne P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
- Summerfield, M.A. (1991) Global Geomorphology. Wiley & Sons.
- Thornbury, W.D. (1996) Principles of Geomorphology. John Wiley.

Course Code: GEOL-601
Course Name: Engineering Geology
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1:

Role of Engineering geologists in planning, design and construction of major man-made structural features. Site investigation and characterization (relief, lithology, structures, ground water conditions). Foundation treatment; grouting, rock bolting and other support mechanisms.

Unit 2:

Rock aggregates; Significance as construction material. Intact rock and rock mass properties. Concept, mechanism and significance of Rock Quality Designation (RQD). Concept, mechanism and significance of: Rock Structure Rating (RSR), Rock Mass Rating (RMR), Tunneling Quality Index (TQI).

Unit 3:

Geological, geotechnical and environmental considerations for dams and reservoirs. Tunnels and tunneling methods.

Unit 4:

Landslides: Causes, effects and mitigation/preventive measures. Earthquakes: Causes, effects and mitigation measures.

Unit 5:

Geological considerations in the construction of highways and bridges. Case histories related to Indian civil engineering projects: Dams, tunnels, highways and railways.

Course Code: GEOL-602
Course Name: Practical on Engineering Geology
Credit: 2
Full Marks – 50, Pass Marks-20

Computation of reservoir area, catchment area, reservoir capacity and reservoir life. Merits, demerits & remedial measures based upon geological cross sections of project sites. Computation of Index properties of rocks. Computation of RQD, RSR, RMR and 'Q'.

Suggested readings:

- Bell, F.G. (2006) Basic Environmental and Engineering Geology Whittles Publishing.
- Bell, F.G. (2007) Engineering Geology, Butterworth-Heinemann.
- Goodman, R.E. (1993) Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
- Johnson, R.B. and De Graf, J.V. (1988) Principles of Engineering Geology, John Wiley.
- Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique,
- McGraw Hill (CBS Publ).
- Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.

Course Code: GEOL -603

Course Name: Remote Sensing and GIS

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Types and acquisition of aerial photographs. Scale and resolution. Principles of stereoscopy, relief displacement, vertical exaggeration and distortion. Elements of air photo interpretation. Identification of sedimentary, igneous, metamorphic rocks and geomorphic landforms.

Unit 2:

Concepts in remote sensing and EM radiations and its interaction with atmosphere. Platforms, sensors and scanners. Satellites and their characteristics.

Unit 3:

Data formats- raster and vector. Digital image processing, image errors, rectification and restoration, image enhancement, filtering, image rationing. Image classification -supervised and unsupervised classification. Accuracy assessment.

Unit 4:

Introduction to GIS. Datum, coordinate systems and projection systems. Spatial data models and data editing: attribute data input and management, data editing, exploration and analysis. Applications of GIS. Introduction to DEM analysis.

Unit 5:

Concepts of GPS. Components of GIS-GPS receivers. GPS position modes- Point positioning and relative positioning, accuracy and error sources. Integrating GPS data with GIS, Applications in earth system sciences.

Course Code: GEOL-604

Course Name: Practical on Remote Sensing and GIS

Credit: 2 Full Marks –50, Pass Marks-20

Aerial photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms. Creating a FCC from raw data. Registration of satellite data with a toposheet of the area. Enhancing the satellite images; Generating NDVI images and other image ratio and its interpretation. DEM analysis: generating slope map, aspect map and drainage network map and its applications.

Suggested readings:

- Demers, M.N.(1997)Fundamentals of Geographic Information System, John Wiley & sons. Inc.
- Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J. (2001)GPS: Theory &Practice,Springer Wien New York.
- Jensen, J.R. (1996) Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.
- Lillesand, T. M. & Kiefer, R.W. (2007) Remote Sensing and Image Interpretation, Wiley.
- Richards, J.A. and Jia, X. (1999) Remote Sensing Digital Image Analysis, Springer-Verlag.

B. Sc. Three Years (Six Semesters) Course
Under
Choice Based Credit System
DISCIPLINE SPECIFIC ELECTIVE

Course Code: GEOL (DSE)-505(i)
Course Name: Exploration Geology
Credit: 4,
Full Marks – 100, Pass Marks– 40

Unit 1:

Resource, reserve - definitions. Prospecting and exploration-conceptualization, methodology and stages. A brief overview of classification of mineral deposits with respect to processes of formation from the perspective exploration.

Unit 2:

Principles of mineral exploration. Sampling, Geochemical exploration, Remote sensing, Geophysical prospecting. Ore grade, Assessment of grade.

Unit 3:

Evaluation of data – mean, mode, median, standard deviation and variance. Core and non-core drilling. Planning of bore holes and location of boreholes on ground. Core-logging.

Unit 4:

Reserve estimations and errors. Principles of reserve estimation, density and bulk density, Factors affecting reliability of reserve estimation, Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks).

Unit 5:

Principles of Mineral economics: strategic, critical and essential minerals. National and domestic mineral policies. Mineral concession rules. Surface and sub-surface sampling including pitting, trenching and drilling.

Course Code: GEOL (DSE) -506(i)
Course Name: Practical on Exploration Geology
Credit – 2
Full Marks – 50, Pass Marks - 20

Identification of anomaly. Concept of weighted average in anomaly detection. Geological cross-section. Models of reserve estimation.

Suggested readings:

- Arogyaswami, R.P.N. (1996) Courses in Mining Geology. 4th Ed. Oxford-IBH.
- Clark, G.B. (1967) Elements of Mining. 3rd Ed. John Wiley & Sons.
- Moon, C.J., Whateley, M.K.G., Evans, A.M. (2006) Introduction to Mineral Exploration, Blackwell Publishing.

Course Code: GEOL (DSE)-505(ii)
Course Name: Evolution of life through time
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1:

Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio-events. Fossilization processes and modes of fossil preservation.

Unit 2:

Biosphere as a system, processes and products. Biogeochemical cycles. Microbes-mineral interactions, microbial mats.

Unit 3:

Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life. Precambrian microfossils – The garden of Ediacara.

Unit 4:

The Cambrian Explosion. Origin of vertebrates and radiation of fishes. Origin of tetrapods - Life out of water. Early land plants and impact of land vegetation.

Unit 5:

Life after the largest (P/T) mass extinction, life in the Jurassic seas. Origin of mammals. Rise and fall of dinosaurs. Origin of birds and spread of flowering plants.

Course Code: GEOL (DSE) -506(ii)
Course Name: Practical on Evolution of life through time
Credit-2
Full Marks – 50, Pass Marks – 20

Study of fossils from different stratigraphic levels. Exercises related to major evolutionary trends in important groups of animals and plants.

Suggested readings:

- Canfield, D.E. & Konhauser, K.O. (2012) Fundamentals of Geobiology Blackwell.
- Cowen, R. (2000) History of Life, Blackwell.
- Jonathan I. Lumine W.H. Freeman Earth-Evolution of a Habitable World, Cambridge University Press.
- Stanley, S.M. (2008) Earth System History.

Course Code: GEOL (DSE) -507(i)
Course Name: Geology of Nagaland
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1

Introduction to Geology of Nagaland: physiography, stratigraphy, fossil content and tectonic setting.

Unit 2

Belt of Schuppen: stratigraphy, structure and petrology of the litho-units. Geological characteristics of thrusts with special reference to the Naga and Disang thrusts.

Unit 3

Inner Fold Belt: stratigraphy, structure and petrology of the various litho-units.

Unit 4

Naga Ophiolite Belt: major litho-units, structure, tectonic setting and evolution.

Unit 5

Mineral resources of Nagaland with special reference to coal, petroleum, limestone, chromite and serpentinite.

Course Code: GEOL (DSE) -508(i)
Course name: Practical on Geology of Nagaland
Credit-2
Full Marks – 50, Pass Marks – 20

Megascopic studies of Disang shale, Barail sandstone, Surma sandstone, Tipam sandstone, Girujan clay, Dihing pebbles and boulders, vesicular basalt, spilite, gabbro, pyroxenite, peridotite, serpentinite, dolerite, plagiogranite, blue schist, phyllite, marble, limestone and conglomerate. Study of the following minerals: asbestos, coal, chert, chromite, magnetite, talc and jadeite. Study of available fossils of Nagaland.

Suggested readings:

- Geology of Nagaland Ophiolite (1982) Geological Survey of India Memoirs, v. 119.
- Ghose, N.C. Phanerozoic Ophiolites of India Sumna Publishers & Distributors, Patna.
- Krishnan, M.S. (1982) Geology of India and Burma. CBS Publishers & Distributors.
- Kumar, R. (1985) Fundamental of Historical Geology and Stratigraphy of India (3rded) Wiley Eastern.
- Nandy, D.R. (2001) Geodynamics of North-eastern India and the Adjoining Region. ACB Publications.
- Srivastava, S.K. (2016) Recent trends in Earth Science Research with special reference to NE India, (Ed) Todays and Tomorrow Printers and Publishers.
- Mekro, Vizovol (2014) Rocks of Nagaland, Mittal Publications.
- Wadia, D.N. (1957) Geology of India (3rd ed).

Course Code: GEOL (DSE) -507(ii)
Course Name: Introduction to Geophysics
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1:

Interrelationship between geology and geophysics. Role of geological and geophysical data in explaining geodynamical features of the earth.

Unit 2:

Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications. Concepts and usage of corrections in geophysical data.

Unit 3:

Different types of surveys, grid and route surveys, profiling and sounding techniques. Scales of survey, Presentation of geophysical data.

Unit 4:

Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.

Unit 5:

Correction to measured quantities, geophysical anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration

Course Code: GEOL (DSE) -508(ii)
Course Name: Practical on Introduction to Geophysics
Credit-2
Full Marks – 50, Pass Marks – 20

Anomaly and background- Graphical method. Study and interpretation of seismic reflector geometry. Problems on gravity anomaly

Suggested readings:

- Dobrin, M.B. (1984) An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
- Bhimasarikaram V.L.S. (1990) Exploration Geophysics - An Outline. Association of Exploration Geophysicists, Osmania University, Hyderabad.
- Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge university press.
- Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.
- Ramachandra Rao, M.B. (1975) Outlines of Geophysical Prospecting - A manual for geologists University of Mysore, Mysore.

Course Code: GEOL (DSE) -605(i)
Course Name: Environmental Geology
Credit: 4
Full Marks – 100, Pass Marks– 40

UNIT 1

Introduction to environmental geology; cultural and environmental awareness, geology abasic environment awareness, geology as a basic environmental Science. Earth as a system, Sustainability and limitation of resources.

UNIT 2

Environmental pollution: causes, impacts, remediation/mitigation measures of air and water pollution. Vehicular pollution.

UNIT 3

Geological hazards: Primary and secondary hazards, Seismic engineering, early warning systems, Planning and education. Stabilizing hill slopes and controlling landslides, Vulnerability zone, types and mitigation measures.

UNIT 4

Anthropogenic hazard: causes, impact and preventive measures on deforestation. Soil sickness, soil loss equation, conservation method.

UNIT 5

Geo- environmental Problems of NE India: Geological and topographic characteristics, climate, drainage, groundwater, soil, land use, land capability, forest cover and their mitigation.

Course Code: GEOL (DSE) -606(i)
Course name: Practical on Environmental Geology
Credit-2
Full Marks – 50, Pass Marks – 20

Case studies on population growth, deforestation, water and air pollution, earthquake zones of the world, landslide zonation maps and geoenvironmental problems of North east India.

Suggested readings:

- Alley, W.M. (1993) Regional Groundwater Quality. VNR, New York.
- Bell, F.G. (1999) Geological Hazards. Routledge.
- Bryant, E. (1985) Natural Hazards. Cambridge University Press.
- Asthana, D.K. (2006) Environmental Problems and Solutions. S. Chand Publications.
- Sivakumar, R. (2013) Environmental Science and Engineering. Sri Krishna Hitech Publishing Company Pvt. Ltd.
- Sharma, P.D. (2012) Ecology and Environment. Rastogi Publications.
- Keller, E.A. (1978) Environmental Geology. Bell & Howell.
- Sharma, P.V. (1997) Environmental and Engineering Geophysics. Cambridge University Press.
- Smith, K. (1992) Environmental Hazards. Routledge.
- Subramaniam, V. (2001) Textbook of Environmental Science. Narosa International.
- Valdiya, K.S. (1987) Environmental Geology - Indian Context. Tata McGraw Hill.

Course Code: GEOL (DSE) -605(ii)

Course Name: Urban Geology

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Geology in Urban Constructions. Geotechnical feature and mapping for subsurface in Metropolitan areas. Building materials. Excavation and cutting in urban areas.

Unit 2:

Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer. Effect of pollutants on vegetable contamination.

Unit 3:

Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban land-use, Geological problems in construction of underground structures in urban areas.

Unit 4:

Water lagging in built-up areas, Source of water, Standards for various uses of water. Sources of contamination. Waste waters: Sources and its disinfection and treatment.

Unit 5:

Geotechnical characterization for waste sites- Domestic waste, industrial waste. Need for special purpose mapping for selection of waste disposal sites.

Course Code: GEOL(DSE) -606(ii)

Course Name: Practical on Urban Geology

Credit-2

Full Marks – 50, Pass Marks – 20

Map Reading. Ground water flow direction estimation. Case studies of Urban flood; Flood hydrographs. Case studies of urban planning.

Suggested readings:

- Huggenberger, P. and Eptin, J. (2011) Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management. Springer.
- Lollino, G., Giordan, D., Crosta, G.B., Corominas, J., Azzam, R., Wasowski, J., Sciarra, N. (2015) Engineering Geology for Society and Territory - Applied Geology for Major Engineering Projects, Vol. 6. Springer.

Course Code: GEOL (DSE) -607(i)

Course Name: Fuel Geology

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Definition and origin of Coal. Basic classification of coal. Introduction to lithotypes, micro lithotypes and macerals in coal, Proximate and Ultimate analysis.

Unit 2:

Coal Bed Methane (CBM) - introduction, reservoir properties, storage and transport. Underground coal gasification and liquefaction.

Unit 3:

Chemical composition and physical properties of petroleum. Origin and migration of oil. Properties of reservoir rocks. Drilling methods.

Unit 4:

Reservoir rocks - clastic and chemical., hydrocarbon traps - structural, stratigraphic and combination, Cap rocks - definition and general properties.

Unit 5:

Gas Hydrates. Radioactive minerals: Occurrence and origin of Uranium and Thorium bearing minerals, reserves in India. Nuclear waste disposal.

Course Code: GEOL (DSE) -608(i)

Course Name: Practical on Fuel Geology

Credit – 2

Full Marks – 50, Pass Marks – 20

Study of hand specimens of coal. Reserve estimation of coal. Section correlation and identification of hydrocarbon prospect. Panel and Fence diagrams.

Suggested readings:

- Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.
- Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
- Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
- Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.

Course Code: GEOL (DSE) -607(ii)

Course Name: Earth and Climate

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Components of the climate system. Climate forcing, Climate controlling factors. Climate system response, response rates and interactions within the climate system.

Unit 2:

Incoming solar radiation, receipt and storage of heat. Heat transfer formation. Earth's heat budget. Interactions amongst various sources of earth's heat.

Unit 3:

Layering of atmosphere and atmospheric Circulation. Atmosphere and ocean interaction and its effect on climate. Heat transfer in ocean. Global oceanic conveyor belt and its control on earth's climate.

Unit 4:

Climate Change: natural vs. anthropogenic effects. Humans and climate change. Brief introduction to archives of climate change.

Unit 5:

Milankovitch cycles and variability in the climate. Glacial-interglacial stages. Pleistocene Glacial-Interglacial cycles. Marine isotope stages.

Unit 6:

Mechanism of monsoon. Monsoonal variation through time. Factors associated with monsoonal intensity. Effects of monsoon.

Course Code: GEOL (DSE) -608(ii)

Course Name: Practical on Earth and Climate

Credit-2

Full Marks – 50, Pass Marks - 20

Study of distribution of major climatic regimes of India on map. Distribution of major wind patterns on World map. Preparation of paleogeographic maps of India through time. Numerical exercises on interpretation of proxy records for paleoclimate

Suggested readings:

- Rudiman, W.F. (2001) Earth's climate: past and future. Edition 2, Freeman Publisher.
- Rohli, R.V., and Vega, A.J. (2007) Climatology. Jones and Barlett.
- Lutgens, F., Tarbuck, E., and Tasa, D.(2009)The Atmosphere: An Introduction to Meteorology.Pearson Publisher.
- Aguado, E., and Burt, J. (2009) Understanding weather.

Course Code: GEOL (DSE) -607(iii)

Course Name: River Science

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1:

Basic stream hydrology. Physical properties of water, sediment and channel flow. River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis. Flood frequency analysis.

Unit 2:

Sediment source and catchment erosion processes. Sediment load and sediment yield. Sediment transport processes in rivers. Erosion and sedimentation processes in channel.

Unit 3:

Drainage network. Quantitative analysis of network organization – morphometry. Random Topology (RT) model and fractal analysis. Role of drainage network in flux transfer. Evolution of drainage network in geological time scale.

Unit 4:

River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers. Channel patterns in stratigraphic sequences. Different classification approaches in fluvial geomorphology and its applications.

Unit 5:

Bedrock channels, Bedrock incision process. River response to climate, tectonics and human disturbance. Bedrock channel processes and evolution of fluvial landscapes. Integrated approach to stream management. Introduction to river ecology.

Course Code: GEOL (DSE) -608(iii)

Course Name: Practical on River Science

Credit: 2

Full Marks – 50, Pass Marks - 20

Stream power calculation. Longitudinal profile analysis. Hydrograph analysis and other related problems.

Suggested readings:

- Bryirely and Fryirs (2005) Geomorphology and river management. Blackwell Pub.
- Davies, T. (2008) Fundamentals of hydrology. Routledge Publications.
- Julien, P.Y. (2002) River Mechanics. Cambridge University Press
- Knighton, D. (1998) Fluvial forms and processes: A new perspective. Amold Pubs.
- Richards. K. (2004) Rivers: Forms and processes in alluvial channels. Balckburn Press.
- Robert, A. (2003) River Processes: An introduction to fluvial dynamics. Arnold Publications.
- Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American Geophyscial Union Monogrpah, Washington, DC.
- Vanoni, V.A. (2006) Sedimentation Engineering. ASCE Manual, Published by American Society ofCivil Engineering.

B. Sc. Three Years (Six Semesters) Course
Under
Choice Based Credit System
SKILL ENHANCEMENT COURSE

Field Work-I

Course Code: GEOL (SEC) –309

Course Name: Basic field training

Credit: 4, Full Marks – 100, Pass Marks - 40

Orientation of Topographic sheet in field, marking location in toposheet, Bearing (Front and back). Concepts of map reading, Distance, height and pace approximation. Identification of rock types in field; structures and texture of rocks, Use of hand lens. Basic field measurement techniques: Bedding dip and strike, Litho-log measurement. Reading contours and topography.

Field Work-II

Course Code: GEOL (SEC) -409(i)

Course Name: Precambrian Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Field transect in any Precambrian terrain. Study of craton ensemble including basic intrusive suites. Precambrian sedimentary basin. Basement-Cover relation in old belts and sedimentary successions.

or

Field Work-II

Course Code: GEOL (SEC) -409(ii)

Course Name: Tertiary Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Field training along Tertiary terrain. Documentation of stratigraphic details in the field. Collection of sedimentological, stratigraphic and structural details.

or

Course Code: GEOL (SEC) -409(iii)

Course Name: Economic Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Module I

Visit to any mineral deposit. Mode occurrence of ore and ore mineralogy. Ore formation process. Basic techniques of surveying, concept of outcrop mapping.

Module 2

Visit to underground or open cast mine. Practical experience of mining methods. Underground mapping/ Bench mapping.

B. Sc. Three Years (Six Semesters) Course
Under
Choice Based Credit System
GENERIC ELECTIVE

Course Code: GEOL (GE) -105(i)
Course Name: Essentials of Geology
Credit: 4
Full Marks – 100, Pass Marks - 40

Unit 1: Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences.

Unit 2: Earth in the solar system: origin, size, shape, mass, density, rotational and evolutionary parameters. Solar System- Introduction to various planets - Terrestrial Planets and jovian Planets. Internal constitution of the earth - core, mantle and crust.

Unit 3: Convections in the earth's core and production of magnetic field. Origin and composition of hydrosphere and atmosphere.

Unit 4: Origin of biosphere. Origin of oceans, continents and mountains.

Unit 5: Age of the earth; Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils.

Course Code: GEOL (GE) -106(i)
Course Name: Practical on Essentials of Geology
Credit-2
Full Marks – 50, Pass Marks – 20

Study of major geomorphic features and their relationships with outcrops through physiographic models. Study of topographic sheets and preparation of physiographic description of an area. Study of soil profile of any specific area. Study of distribution of major litho stratigraphic units on the map of India. Study of distribution of major dams on map of India and their impact on river systems. Study of major ocean currents of the World. Study of seismic profile of a specific area and its interpretation.

Suggested readings:

- Holmes (1991) Principles of Physical Geology. Chapman & Hall.
- Emiliani, C.(1992) Planet Earth, Cosmology, Geology and the Evolution of Life and Environment., Cambridge University Press.
- Gross,M.G.(1977)Oceanography: A view of the Earth, Prentice Hall.

Course Code: GEOL (GE) -105(ii)
Course Name: Earth Surface Processes
Credit: 4, Full Marks – 100, Pass Marks- 40

Unit 1:

Historical development in concepts of earth's surface processes. Concept of geoid, terrestrial relief, scales in geomorphology.

Unit 2:

Weathering and formation of soils, karst and speleology, slope and catchment erosion processes, fluvial, eolian, glacial, peri-glacial and coastal processes and resultant landforms, Water and sediment flux in river systems, Morphometric analysis of drainage basin and geomorphology-hydrology relationship.

Unit 3:

Techniques for measuring rates of processes: sediment budgeting, rock magnetism, isotope geochemical tracers, cosmogenic nuclides, OSL & C-14 dating.

Unit 4:

Controlling factors (tectonics, climate, sea level changes and anthropogenic) and surface processes. Climate change and geomorphic response of fluvial systems of arid and humid regions. Geomorphic response to tectonics, sea level/base level change, anthropogenic affects. Introduction to Anthropocene.

Unit 5:

Spatial and temporal scales, geomorphic system, connectivity, buffering, magnitude-frequency concept, time lag, sensitivity, equilibrium, threshold, non-linearity & complexities. Mega geomorphology and process interrelationship. Surface processes and natural hazards; Applied aspects of geomorphology. Introduction to planetary geomorphology.

Course Code: GEOL (GE) -106(ii)
Course name: Practical on Earth Surface Resources
Credit-2, Full Marks – 50, Pass Marks - 20

Mapping of different landforms and interpretation of surface processes. Exercises on hill slope development, fluvial channel, sediment erosion and transport, sediment budgeting, aggradation and degradation events, drainage basin, drainage morphometry. Basic exercises on computation of rate for different surface processes.

Suggested readings:

- Alien, P.A. (1997) Earth Surface Processes, Blackwell publishing.
- Bloom, A.L. (1998) Geomorphology: A Systematic Analysis of Late Cenozoic Landforms, Pearson Education.
- Bridge, J.S. and Demicco, R.V. (2008) Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
- Esterbrook, D.J. (1992) Surface Processes and Landforms, MacMillan Publ.
- Kale, V.S. and Gupta A (2001) Introduction to Geomorphology, Orient Longman Ltd.
- Leeder, M. & Perez-Arlucea, M (2005) Physical processes in earth and environmental sciences, Blackwell publishing.
- Summerfield, M.A. (1991) Global Geomorphology. Prentice Hall.
- Willcock, P.R. & Iverson R. M. (2003) Prediction in geomorphology. AGU Publication.

Course Code: GEOL (GE) -205(i)
Course Name: Rocks and Minerals
Credit: 4
Full Marks – 100, Pass Marks– 40

Unit 1:

Minerals-Definition. Physical properties of minerals: color, lustre, transparency and translucency, form, hardness, fracture, streak, cleavage, specific gravity. Coordination principle and radius ratio.

Unit 2:

Study of petrological microscope. Nature of light, refractive index, isotropic and anisotropic substances and indicatrices, nicol prism, interference color, extinction, pleochroism absorption, twinning.

Unit 3:

Crystal: definition and characteristics- face, edge, solid angle, zone, zone axis, interfacial angle parameters and indices. Crystallographic axes, axial ratio and symmetry, common crystal forms. Crystal systems.

Unit 4:

Rocks- Definitions and types, Igneous rock- magma generation and differentiation, Metamorphic rocks- chemical system and types of metamorphism

Unit 5:

Sedimentary rocks: sedimentary processes- physical, chemical and biological weathering, transportation, diagenesis. Genetic classification of sedimentary rocks.

Course Code: GEOL (GE) -206(i)
Course Name: Practical on Rocks and Minerals
Credit: 2
Full Marks – 50, Pass Marks- 20

Study of physical properties of minerals. Introduction to optical microscopy. Study of optical properties of minerals. Study of physical properties of rocks. Study of optical properties of rock under thin sections. Understanding crystal symmetry via wooden models. Stereographic projection of mineral faces. Mineral formula calculation. Crystal chemical calculation. Introduction to analytical techniques for rock and mineral study.

Suggested readings:

- Cornelis, K. & Philpotts, A. (2013) Earth Materials- introduction to Mineralogy and Petrology. Cambridge University Press.
- Grotzinger. J & Jordan, T.H. (2010) Understanding Earth (6th Edition), W.H. Freeman and company, New York.

Course Code: GEOL (GE) -205(ii)
Course Name: Soils: Present and Past
Credit: 4
Full Marks – 100, Pass Marks - 40

Unit 1:

Physical and chemical weathering, loosening and particle size reduction; pressure release; thermal expansion; growth of foreign crystal.

Unit 2:

Soil structures; horizons; roots; Fe-Mn mottles and concretions; pedogenic carbonate. Introduction to palaeopedology and paleosols; role of factors controlling palaeosol formation- parent material, climate, vegetation, topography, time.

Units 3:

Introduction to soil taxonomy and paleosol taxonomy. Micromorphology: Thin section analysis of paleosols. Geochemistry: molecular ratios; chemical weathering indices.

Unit 4:

Diagenetic overprinting in fossil soils: compaction; oxidation of organic matter; cementation; Illitization. Geological record of fossil soils.

Unit 5:

Pleistocene-Holocene paleosols- human impact on landscape and soils, climate change, neotectonics. Paleosols and non-marine sequence stratigraphy based on palaeopedology and sedimentology of fluvial successions.

Course Code: GEOL (GE) -206(ii)
Course Name: Practical on Soils - Present and Past
Credit: 2
Full Marks – 50, Pass Marks- 20

Micromorphic detailing of the paleosols- structure, horizonation, color, rhizcretions, pedogenic, carbonate etc. Particle size analysis and clay mineral analysis of the paleosols. Micromorphological analysis- thin section preparation, description, and interpretation. Geochemical analysis- bulk geochemistry, molecular ratios and weathering indices. Field trip to examine modern and fossil soils- field characterization and sampling procedures.

Suggested readings:

- Retallack, G.J. (2001) Soils of the Past: An Introduction to Paleopedology (2nd edition): Oxford, Blackwell Science, Ltd.
- Birkeland, P.W. (1999) Soil and Geomorphology. Oxford University Press.
- reconstruction using paleosols. Earth-Science Reviews 95.
- Stoops, G. (2003) Guidelines for analysis and distribution of soil and regolith thin sections. SoilSci. Soc. Am., Madison, Wisconsin.
- Bhattacharyya T., Sarkar, D., Pal, D. K. (Eds.) Soil Survey Manual. NBSSLUP Publication.

Course Code: GEOL (GE) -307(i)
Course Name: Fossils and their application
Credit: 4
Full Marks – 100, Pass Marks - 40

Unit 1:

Definition of fossil, Types, fossilization processes (taphonomy), modes of fossil preservation, fossils sampling techniques, uses of fossils.

Unit 2:

Definition of species, speciation, methods of description and naming of fossils, code of systematic nomenclature.

Unit 3:

Brief introduction of important fossils groups: invertebrate, vertebrate, microfossils, spore, pollens and plant fossils. Important age-diagnostic fossiliferous horizons of India.

Unit 4:

Principles and methods of paleoecology, application of fossils in the study of paleoecology, paleobiogeography and paleoclimate.

Unit 5:

Morphological study and geological distribution of the following classes: brachiopoda, lamellibranchia, gastropoda and cephalopoda.

Course Code: GEOL (GE) -308(i)
Course Name: Practical on Fossils and their applications
Credit: 2
Full Marks – 50, Pass Marks - 20

Study of fossils showing various modes of fossilization. Distribution of age diagnostic fossils in India. Biostratigraphic correlation.

Suggested readings:

- Schoch, R.M. (1989) Stratigraphy, Principles and Methods. Van Nostrand Reinhold.
- Clarkson, E.N.K.(1998) Invertebrate Paleontology and Evolution. George Allen & Unwin
- Prothero, D.R. (1998) Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.
- Benton, M.J. (2005) Vertebrate palaeontology (3rd edition). Blackwell Scientific, Oxford.
- **Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time**

Course Code: GEOL (GE) -307(ii)

Course Name: Earth Resources

Credit: 4

Full Marks – 100, Pass Marks - 40

Unit 1:

Definitions of resources and reserves: Historical perspective and present scenario of mineral, energy and water resources. Classification of mineral deposits with respect to processes of formation. Exploration strategies.

Unit 2:

Definition of Energy: Primary and Secondary Energy. Difference between Energy, Power and Electricity. Renewable and Non-Renewable Sources of Energy.

Unit 3:

Major Types and Sources of Energy: Natural Oil and Gas, Coal and Nuclear Minerals. Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass based power and energy.

Unit 4:

Ground water resources and its role in economic development. Impact of urbanization on ground water. Rainwater harvesting and artificial recharge.

Unit 5:

Metallic and non-metallic mineral deposits and their conservation. Concept and significance of renewability: Social, economic, political and environmental dimension of energy.

Course Code: GEOL (GE) -308(ii)

Course Name: Practical on Earth Resources

Credit-2

Full Marks – 50, Pass Marks - 20

Plotting of major Indian oil fields on map of India. Problems related to hydroelectric power generation. Problems related to assessment of possible oil exploration site from geological maps. Problems related to energy demand projection of India and possible mitigation pathways. Problems related to bio fuel.

Suggested readings:

Fowler, J.M. (1984) Energy and the Environment. McGraw-Hill.

Nebojsa Nakicenovic (1998) Global Energy Perspectives, Cambridge University Press.

Tushar K. Ghosh & A. Prelas. (2009) Energy Resources and Systems: Fundamentals and Non-Renewable Resources, Springer.

Course Code: GEOL (GE) -407(i)

Course Name: Natural hazards and Disaster Management

Credit: 4

Full Marks – 100, Pass Marks– 40

Unit 1: The Lithosphere and Related Hazards Atmospheric Hazards, Hydrosphere and Related Hazards

Unit 2:

Types of disaster: cyclone, flood, landslide, land subsidence, fire and earthquake, tsunami and volcanic eruption.

Unit 3:

Disaster management, mitigation, and preparedness, Techniques of monitoring and design against the disasters. Management issues related to disaster.

Unit 4:

Risk, vulnerability and hazard. Mitigation through capacity building, Pre-disaster risk & vulnerability reduction, Post disaster recovery & rehabilitation.

Unit 5:

Emergency alert System, management, disaster related infrastructure development.

Course Code: GE (GEOL) -408(i)

Course Name: Practical on Natural hazards and Disaster Management

Credit: 2

Full Marks – 50, Pass Marks - 20

Trainings in first aid, relief, rescue and mock drill. The course will also include discussions on topics assigned to students based on their interest.

Suggested readings:

- Bell, F.G.(1999) Geological Hazards, Routledge, London.
- Bryant, E. (1985) Natural Hazards, Cambridge University Press.
- Smith, K.(1992) Environmental Hazards. Routledge, London.
- Subramaniam, V. (2001) Textbook in Environmental Science, Narosa International.

Course Code: GEOL (GE) -407(ii)
Course Name: Nuclear Waste Management
Credit: 4
Full Marks – 100, Pass Marks - 40

Unit 1:

Nuclear reactors and generation of nuclear waste, nuclear fuel cycle.

Unit 2:

Basic concepts about nuclear waste management. Classification, composition and types of nuclear waste, their sources and characteristics.

Unit3:

Introduction to immobilization and vitrification processes. Nuclear waste forms and containments. Immobilization of nuclear waste in synthetic glasses and natural glass/rocks (acidic: obsidian, rhyolite and basic: nephiliniite and basaltic).

Unit 4:

Glass/rock characterization and its long-term performance assessment. Geochemistry of glass/rock-water interaction-solution and neoformed mineral chemistry.

Unit 5:

Nuclear waste confinement and safe disposal in deep geological repositories. Application of clays as natural barriers.

Course Code: GEOL (GE) -408(ii)
Course Name: Practical on Nuclear Waste Management
Credit: 2
Full Marks – 50, Pass Marks - 20

Determination of physical properties such as hardness, durability, melting and pouring temperatures. Chemical characterization of synthetic and natural glass. Mathematical modelling and extrapolation of synthetic glass alterations. Mathematical modelling and extrapolation of natural acidic (obsidian, rhyolite) and basic (nephilinite and basaltic) glasses. Determination of rate of alteration and recognition of neo-formed minerals. Calculation of retention coefficient for glass residue.

Suggested readings:

- Bethke, C. M. (2007). Geochemical and biogeochemical reaction modeling. Cambridge University Press.
- Ojovan, M. I., & Lee, W. E. (2013). An introduction to nuclear waste immobilisation.
- Newnes.
- Saling, J. (2001). Radioactive waste management. CRC Press.
- T.G. Wolery: Reaction path modelling of aqueous geochemical systems.

GEOLOGY SYLLABUS B.Sc. PASS COURSE CBCS - 2022

Core Papers (4 papers for each discipline)

Paper Code	Course Code	Title of the paper	Credit
DSC-1A	GEOL DSC-1A	Physical Geology, Remote Sensing and Structural Geology	Theory:4 Credit Practical: 2 Credit
DSC -1B	GEOL DSC-1B	Mineral Science	Theory:4 Credit Practical: 2 Credit
DSC-1C	GEOL DSC-1C	Petrology (Igneous, Sedimentary and Metamorphic) and Economic Geology	Theory:4 Credit Practical: 2 Credit
DSC-1D	GEOL DSC-1D	Palaeontology, Stratigraphy and Environmental Geology	Theory:4 Credit Practical: 2 Credit

Skill Enhancement Courses (2 Credit Each)

Paper Code	Course Code	Title of the paper	Credit
SEC-1	GEOL SEC-1	Geological Field Work-I	2 Credit
SEC-2	GEOL SEC-1	Geological Field Work-II	2 Credit
SEC-3			
SEC-4			

DISCIPLINE SPECIFIC ELECTIVE (6 Credit Each)

Paper Code	Course Code	Title of the paper	Credit
DSE1A	GEOL DSE-1A	(i) Exploration Geology or (ii) Evolution of life through time or (iii) Geology of Nagaland	Theory:4 Credit Practical: 2 Credit
DSE1B	GEOL DSE-1B	(i) Environmental Geology or (ii) Urban Geology or (iii) Fuel Geology	Theory:4 Credit Practical: 2 Credit

Semester-wise Course Distribution (B.Sc. General Course)*

YEAR	Semester	Discipline Specific Core Courses (Total 12; Each Subject-4)	Ability Enhancement Compulsory Course (AECC) (Total:2)	Skill Enhancement Course (SEC), Total: 4	Discipline Specific Elective (DSE) (Total: 6; Each Subject-2)
1 ST Year	I	Physical Geology, Remote Sensing and Structural Geology	AECC- 1: English /MIL/ Hindi Communication		

	II	Mineral Science	AEC- 2: Environmental Science		
2ND Year	III	Petrology (Igneous, Sedimentary and Metamorphic) and Economic Geology		SEC-1 (Geological Field Work-I)	
	IV	Palaeontology, Stratigraphy and Environmental Geology		SEC-2 (Geological Field Work-II)	
3RD Year	V			SEC-3	DSE-1A: (i) Exploration Geology or (ii) Evolution of life through time or (iii) Geology of Nagaland
	VI			SEC-4	DSE-1B: (i) Environmental Geology or (ii) Urban Geology or (iii) Fuel Geology

*Modalities of Examination will be prepared by the Examination Section, Nagaland University as per NEP 2020 Guidelines.

**B. Sc. (General) Three Years (Six Semesters) Course
(Choice Based Credit System)
DISCIPLINE SPECIFIC CORE COURSE: GEOLOGY**

Course Code: GEOL DSC-1A

Course Name: Physical Geology, Remote Sensing and Structural Geology

Credit: 4; Full Marks – 100, Pass Marks – 40

UNIT-1: Origin and age of the earth. Position of the earth in the solar system. The crust and interior of the earth: internal structure, discontinuities, density variation and chemical composition of various layers of the earth. Hydrosphere, atmosphere and biosphere.

UNIT-2: Elementary idea of Continental Drift and Plate Tectonics. Concept of Isostasy and orogeny. Earthquakes and their causes. Earthquake zones of India. Volcanoes - types and distribution. Rock weathering and erosion. Geological action of wind, rivers, and glaciers.

UNIT-3: Principles of remote sensing. Advantages and application of remote sensing. Introduction to sensors: Active and Passive sensors; Imaging and Non-imaging sensors. Elementary ideas about satellites and their orbits. Aerial photographs and types.

UNIT-4: Study of outcrops, identification of bedding and attitude of planes - dip and strike; Clinometer and Brunton compass and their uses. Effects of topography on outcrops. Inlier and outlier. Unconformities: description and types. Determination of top and bottom of layered rocks.

UNIT-5: Definition and types of folds, faults and joints. Brief description and classification of cleavage/foliation and lineation. Tectonic features of India with special reference to the North East.

Practical on Physical Geology, Remote Sensing and Structural Geology

Credit: 2; Full Marks – 50, Pass Marks – 20

Study of geomorphic models. Study of aerial photographs using pocket stereoscope.

Study of structural models. Solution to problems of dip and strike of outcrops. Study and interpretation of simple geological maps containing folds, faults and unconformities. Tectonic and seismic maps of India.

Viva Voce

Practical Record

Suggested readings:

- Agarwal, C.S. and Garg, P.K. 2000: Textbook on Remote sensing in Natural resources monitoring and management. Wheeler Publishing.
- Billings, M.P. 2004: Structural Geology (3rd ed). Prentice Hall.
- Davis, G.H, Stephen, J.R, Charles, F.K. 1984: Structural Geology of Rocks and Regions. John Wiley.
- Duff, D. 1993: Holmes' Principles of Physical Geology. 4th edition. Routledge.
- Hobbs, B. E, Means, W.D. and Williams, P.F. 1976: An Outline of Structural Geology.
- Joseph, G. 2005: Fundamentals of Remote Sensing. (2nd ed). Universities Press.
- Lahee, F.H. 2002: Field Geology. (6th ed). CBS Publishers. Mukerjee, P. K: A text book of geology. 13 reprint editions. The World Press.
- Ludman, A and Marshak, S. 2012: Laboratory Manual for Introductory Geology (2nd ed). W.W. Norton Publisher.
- Mukerjee, P. K. A text book of geology. 13 reprint editions. The World Press.
- Park, R.G. 1997: Foundations of Structural Geology (3rded.), Routledge Taylor & Francis, London & New York.
- Sen, A. K.: Laboratory Manual of Geology. Modern Book Agency (P) Ltd., Kolkata.

Course Code: GEOL DSC-1B

Course Name: Mineral Science

Credit: 4; Full Marks – 100, Pass Marks – 40

UNIT-1: Elementary ideas about crystal morphology in relation to internal structures. Face, edge, solid angle, zone, interfacial angle, Crystal parameters and indices. Crystal symmetry and common crystal forms- dome, prism, pyramid and pinacoid.

UNIT-2: Study of normal classes of the Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems. Classification of 32 point groups.

UNIT-3: Mineral – definition, classification and physical properties. Isomorphism, polymorphism and pseudomorphism. Silicate structures with examples. Cubic close packing and hexagonal close packing.

UNIT-4: Study of common rock-forming minerals – Silica (quartz), feldspar, pyroxene, amphibole, mica, aluminosilicate, garnet and olivine groups.

UNIT-5: Introduction to the petrological microscope. Nature of light: ordinary and polarized light, isotropic and anisotropic substances, refractive index, birefringence, pleochroism, twinkling, interference colour, extinction and twinning.

Practical on Mineral Science

Credit: 2; Full Marks – 50, Pass Marks – 20

Study of elements of symmetry and forms of the normal classes of the Isometric, Tetragonal, Hexagonal and Orthorhombic systems.

Identification of the following minerals in hand specimens by their physical characters - quartz, orthoclase, plagioclase, augite, hornblende, tremolite, muscovite, biotite, chlorite, staurolite, garnet, beryl, nepheline, tourmaline, kyanite, sillimanite, calcite, talc, gypsum, fluorite, apatite, topaz and corundum.

Identification of the following minerals under the microscope - quartz, orthoclase, microcline, plagioclase, muscovite, biotite, augite, hypersthene, hornblende, olivine, garnet, and calcite.

Suggested readings:

- Deer, W.A., Howie, R.A., and Zussman. J., 1996. The Rock forming Minerals. Longman.
- Kerr, P. F. (1959). Optical Mineralogy. McGraw- Hill.
- Klein, C., Dutrow, B., Dwight, J.: The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
- Verma, P. K. (2010). Optical Mineralogy. Ane Books Pvt Ltd.
- Sen, A. K.: Laboratory Manual of Geology. Modern Book Agency (P) Ltd., Kolkata.

Course Code: GEOL DSC-1C

Course Name: Petrology (Igneous, Sedimentary, Metamorphic) and Economic Geology

Credit: 4; Full Marks – 100, Pass Marks – 40

UNIT-1: Magma - definition, composition and origin. Forms and mode of occurrence of igneous rocks. Phase equilibrium of uni-component (augite) and bi-component systems (albite-anorthite). Bowen's reaction series. Magmatic differentiation and assimilation. Textures and structures of igneous rocks. Textural and chemical (silica) classifications of igneous rocks. Petrography and origin of granite, diorite, gabbro, dolerite, basalt, peridotite.

UNIT-2: Sedimentary processes: weathering and origin of sediments, transportation, deposition; diagenesis and lithification of terrigenous and chemical sediments. Classification of sedimentary rocks (clastic, non clastic and evaporates). Textures and structures of sedimentary rocks. Aeolian, fluvial, near-shore and deep-sea environments. Classification of sandstones and limestones.

UNIT-3: Metamorphism – definition, types and agents. Texture and structure of metamorphic rocks. Index minerals and Barrovian zones. Progressive and retrogressive metamorphism. Concept of ACF, AKF and AFM diagrams. Concept of metamorphic facies. Petrological studies of schist, gneiss, quartzite and marble.

UNIT-4: Definition of ore, gangue, and tenor. Ore forming minerals, concepts of metallic and non-metallic ore deposits. Processes of formation of ores: magmatic, hydrothermal, skarns, sedimentary, metamorphic, evaporates; oxidation and supergene enrichment. Metallogenic provinces and epochs.

UNIT-5: Occurrence, origin, uses, and distribution of the following economic mineral deposits of India: iron, manganese, chromium, lead, zinc, copper, aluminum, gold, coal and petroleum. Mineral resources of North East India.

Practical on Petrology (Igneous, Sedimentary and Metamorphic) and Economic Geology

Credit: 2; Full Marks – 50, Pass Marks – 20

Megascopic and microscopic studies of granite, syenite, diorite, dolerite, gabbro, peridotite, dunite, basalt, rhyolite, trachyte and obsidian.

Megascopic studies of breccia, conglomerate, shale, sandstone and limestone. Microscopic study and diagenetic features of sandstones and limestones.

Megascopic and microscopic studies of schist, gneiss, quartzite, marble, granulite and amphibolite.

Identification of the following economic minerals in hand specimen- graphite, chalcopyrite, pyrite, hematite, magnetite, chromite, pyrolusite, psilomelane, corundum, coal, gypsum, fluorite, galena, sphalerite, sillimanite, kyanite, calcite, barite, muscovite, biotite, magnesite, stibnite, molybdenite, apatite, bornite and talc.

Suggested readings:

- Bose, M.K. 1997: Igneous Petrology. World Press.
- Hatch, F.H., Wells, A.K. and Wells, M.K. 1984: Petrology of Igneous Rocks. CBS Publishers..
- Nockolds, S.R., Knox, R.W.O.B. and Chinner, G.A. 1979: Petrology for Students. Cambridge University Press.
- Introduction to sedimentology by S.M. Sengupta (Routledge Publisher)

- Petrology of Sedimentary rocks by Green Smith (CBS Publishers, India)
- Sedimentary Rocks by Pettijohn (CBS Publishers, India)
- Tyrrell, G.W. (1926). Principles of Petrology. Springer.
- Raymond, L. A. (2002). Petrology: The study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
- Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.
- Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
- Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
- Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley.
- Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
- Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
- Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

Course Code: GEOL DSC-1D

Course Name: Palaeontology, Stratigraphy and Environmental Geology

Credit: 4; Full Marks – 100, Pass Marks – 40

UNIT-1: Definition and scope of palaeontology. Process of fossilization and preservation. Origin and evolution of life; the fossil record. Taxonomy and systematic nomenclature of fossils. Application of palaeontology in evolution and stratigraphy.

UNIT-2: Morphology and geological distribution of Mollusca (gastropods, bivalves, cephalopods), brachiopoda, Echinodermata and trilobites.

UNIT-3: Definition and principles of stratigraphy. Geological Time Scale. Lithostratigraphic, chronostratigraphic, and biostratigraphic units. Stratigraphic correlations. Identification of stratigraphic contacts and unconformities. Facies concept in stratigraphy.

UNIT-4: Precambrian and Phanerozoic successions of India – Dharwar, Cuddapah, Vindhyan, Gondwana and Siwalik. Cenozoics of North East India.

UNIT-5: Concept and definition of Environmental Geology. Soil degradation and mitigation. Concepts of natural ecosystems on the earth: atmosphere, hydrosphere, lithosphere and biosphere. Environmental changes due to anthropogenic and natural systems. Introduction to natural hazards – earthquakes and landslides.

Practical on Palaeontology, Stratigraphy and Environmental Geology

Credit: 2; Full Marks – 50, Pass Marks – 20

Morphology and geological ranges of the following- *Calceola*, *Zaphrentis*, *Productus*, *Spirifer*, *Terebratula*, *Rhynchonella*, *Arca*, *Corbula*, *Cardita*, *Exogyra*, *Lima*, *Mytilus*, *Nucula*, *Pecten*, *Ostrea*, *Spondylus*, *Trigonia*, *Bellerophon*, *Conus*, *Cyprea*, *Cerithium*, *Murex*, *Natica*, *Physa*, *Turritella*, *Baculites*, *Belemnites*, *Ceratites*, *Goniatites*, *Nautilus*, *Calymene*, *Phacops*, *Glossopteris*, *Gangamopteris*, *Ptillophylum*, *Vertebraria*.

Study of rocks from important stratigraphic horizons of India. Distribution of stratigraphic formations of India during different periods. Case studies of environment related problems.

Suggested readings:

- Invertebrate Palaeontology by Shrock, CBS Publishers, India
- Clarkson, E. N. K. (2012) Invertebrate palaeontology and evolution, 4th Edition by Blackwell Publishing.
- Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Palaeontology.
- Shukla, A. C., & Misra, S. P. (1975). Essentials of Palaeobotany. Vikas Publisher.
- Doyle, P. & Bennett, M. R. (1996). Unlocking the Stratigraphic Record. John Wiley.
- Krishnan, M. S. (1982). Geology of India and Burma, CBS Publishers, Delhi.
- Ramakrishnan, M. & Vaidyanadhan, R. (2008). Geology of India Vol. 1 & 2, Geological Society of India, Bangalore.
- Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.
- Ravindra Kumar (1986). Fundamentals of Historical Geology and Stratigraphy of India.

**B. Sc. (General) Three Years (Six Semesters) Course
(Choice Based Credit System)
DISCIPLINE SPECIFIC ELECTIVE (DSE)**

Course Code: GEOL DSE-1A(i)

Course Name: Exploration Geology

Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1:

Resource, reserve - definitions. Prospecting and exploration-conceptualization, methodology and stages. A brief overview of classification of mineral deposits with respect to processes of formation from the perspective exploration.

Unit 2:

Principles of mineral exploration. Sampling, Geochemical exploration, Remote sensing, Geophysical prospecting. Ore grade, Assessment of grade.

Unit 3:

Evaluation of data – mean, mode, median, standard deviation and variance. Core and non-core drilling. Planning of bore holes and location of boreholes on ground. Core-logging.

Unit 4:

Reserve estimations and errors. Principles of reserve estimation, density and bulk density, Factors affecting reliability of reserve estimation, Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks).

Unit 5:

Principles of Mineral economics: strategic, critical and essential minerals. National and domestic mineral policies. Mineral concession rules. Surface and sub-surface sampling including pitting, trenching and drilling.

Course Code: GEOL DSE-1A (i) P

Course Name: Practical on Exploration Geology

Credit – 2; Full Marks – 50, Pass Marks - 20

Identification of anomaly. Concept of weighted average in anomaly detection. Geological cross-section. Models of reserve estimation.

Suggested readings:

- Arogyaswami, R.P.N. (1996) Courses in Mining Geology. 4th Ed. Oxford-IBH.
- Clark, G.B. (1967) Elements of Mining. 3rd Ed. John Wiley & Sons.
- Moon, C.J., Whateley, M.K.G., Evans, A.M. (2006) Introduction to Mineral Exploration, Blackwell Publishing.

Course Code: GEOL DSE-1A (ii)
Course Name: Evolution of life through time
Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1:

Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio-events. Fossilization processes and modes of fossil preservation.

Unit 2:

Biosphere as a system, processes and products. Biogeochemical cycles. Microbes-mineral interactions, microbial mats.

Unit 3:

Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life. Precambrian macrofossils – The garden of Ediacara.

Unit 4:

The Cambrian Explosion. Origin of vertebrates and radiation of fishes. Origin of tetrapods - Life out of water. Early land plants and impact of land vegetation.

Unit 5:

Life after the largest mass extinction (Permian/Triassic), life in the Jurassic seas. Origin of mammals. Rise and fall of dinosaurs. Origin of birds and spread of flowering plants.

Course Code: GEOL DSE-1A (ii) P
Course Name: Practical on Evolution of life through time
Credit-2
Full Marks – 50, Pass Marks – 20

Study of fossils from different stratigraphic levels. Exercises related to major evolutionary trends in important groups of animals and plants.

Suggested readings:

- Canfield, D.E. & Konhauser, K.O. (2012) Fundamentals of Geobiology Blackwell.
- Cowen, R. (2000) History of Life, Blackwell.
- Jonathan I. Lumine W.H. Freeman Earth-Evolution of a Habitable World, Cambridge University Press.
- Stanley, S.M. (2008) Earth System History.

Course Code: GEOL DSE-1A (iii)
Course Name: Geology of Nagaland
Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1

Introduction to Geology of Nagaland: physiography, stratigraphy, fossil content and tectonic setting.

Unit 2

Belt of Schuppen: stratigraphy, structure and petrology of the litho-units. Geological characteristics of thrusts with special reference to the Naga and Disang thrusts.

Unit 3

Inner Fold Belt: stratigraphy, structure and petrology of the various litho-units.

Unit 4

Naga Ophiolite Belt: major litho-units, structure, tectonic setting and evolution.

Unit 5

Mineral resources of Nagaland with special reference to coal, petroleum, limestone, chromite, magnetite and serpentinite.

Course Code: GEOL DSE-1A (iii) P
Course name: Practical on Geology of Nagaland
Credit-2; Full Marks – 50, Pass Marks – 20

Megascopic studies of Disang shale, Barail sandstone, Surma sandstone, Tipam sandstone, Girujan clay, Dihing pebbles and boulders, vesicular basalt, spilite, gabbro, pyroxenite, peridotite, serpentinite, dolerite, plagiogranite, blue schist, phyllite, marble, limestone and conglomerate. Study of the following minerals: asbestos, coal, chert, chromite, magnetite, talc and jadeite. Study of available fossils of Nagaland.

Suggested readings:

- Geology of Nagaland Ophiolite (1982), Geological Survey of India Memoirs, v. 119.
- Ghose, N.C. Phanerozoic Ophiolites of India Sumna Publishers & Distributors, Patna.
- Krishnan, M.S. (1982) Geology of India and Burma. CBS Publishers & Distributors.
- Kumar, R. (1985) Fundamental of Historical Geology and Stratigraphy of India (3rded) Wiley Eastern.
- Nandy, D.R. (2001) Geodynamics of North-eastern India and the Adjoining Region. ACB Publications.
- Srivastava, S.K. (2016) Recent trends in Earth Science Research with special reference to NE India, (Ed) Today's and Tomorrow Printers and Publishers.
- Mekro, Vizovol (2014) Rocks of Nagaland, Mittal Publications.
- Wadia, D.N. (1957) Geology of India (3rd ed).

Course Code: GEOL DSE-1B (i)
Course Name: Environmental Geology
Credit: 4; Full Marks – 100, Pass Marks– 40

UNIT 1

Introduction to environmental geology; cultural and environmental awareness, geology a basic environment awareness, geology as a basic environmental Science. Earth as a system, Sustainability and limitation of resources.

UNIT 2

Environmental pollution: causes, impacts, remediation/mitigation measures of air and water pollution. Vehicular pollution.

UNIT 3

Geological hazards: Primary and secondary hazards, Seismic engineering, early warning systems, Planning and education. Stabilizing hill slopes and controlling landslides, Vulnerability zone, types and mitigation measures.

UNIT 4

Anthropogenic hazard: causes, impact and preventive measures on deforestation. Soil sickness, soil loss equation, conservation method.

UNIT 5

Geo- environmental Problems of NE India: Geological and topographic characteristics, climate, drainage, groundwater, soil, land use, land capability, forest cover and their mitigation.

Course Code: GEOL DSE-1B (i) P
Course name: Practical on Environmental Geology
Credit-2; Full Marks – 50, Pass Marks – 20

Case studies on population growth, deforestation, water and air pollution, earthquake zones of the world, landslide zonation maps and geoenvironmental problems of North east India.

Suggested readings:

- Alley, W.M. (1993) Regional Groundwater Quality. VNR, New York.
- Bell, F.G. (1999) Geological Hazards. Routledge.
- Bryant, E. (1985) Natural Hazards. Cambridge University Press.
- Asthana, D.K. (2006) Environmental Problems and Solutions. S. Chand Publications.
- Sivakumar, R. (2013) Environmental Science and Engineering. Sri Krishna Hitech Publishing Company Pvt. Ltd.
- Sharma, P.D. (2012) Ecology and Environment. Rastogi Publications.
- Keller, E.A. (1978) Environmental Geology. Bell & Howell.
- Sharma, P.V. (1997) Environmental and Engineering Geophysics. Cambridge University Press.
- Smith, K. (1992) Environmental Hazards. Routledge.
- Subramaniam, V. (2001) Textbook of Environmental Science. Narosa International.
- Valdiya, K.S. (1987) Environmental Geology - Indian Context. Tata McGraw Hill.

Course Code: GEOL DSE-1B (ii)
Course Name: Urban Geology
Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1:

Geology in Urban Constructions. Geotechnical feature and mapping for subsurface in Metropolitan areas. Building materials. Excavation and cutting in urban areas.

Unit 2:

Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer. Effect of pollutants on vegetable contamination.

Unit 3:

Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban land-use, Geological problems in construction of underground structures in urban areas.

Unit 4:

Water lagging in built-up areas, Source of water, Standards for various uses of water. Sources of contamination. Waste waters: Sources and its disinfection and treatment.

Unit 5:

Geotechnical characterization for waste sites- Domestic waste, industrial waste. Need for special purpose mapping for selection of waste disposal sites.

Course Code: GEOL DSE-1B (i) P
Course Name: Practical on Urban Geology
Credit-2; Full Marks – 50, Pass Marks – 20

Map Reading. Ground water flow direction estimation. Case studies of Urban flood; Flood hydrographs. Case studies of urban planning.

Suggested readings:

- Huggenberger, P. and Eptin, J. (2011) Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management. Springer.
- Lollino, G., Giordan, D., Crosta, G.B., Corominas, J., Azzam, R., Wasowski, J., Sciarra, N. (2015) Engineering Geology for Society and Territory - Applied Geology for Major Engineering Projects, Vol. 6. Springer.

Course Code: GEOL DSE-1B (iii)
Course Name: Fuel Geology
Credit: 4; Full Marks – 100, Pass Marks– 40

Unit 1:

Definition and origin of Coal .Basic classification of coal.Introduction to lithotypes, micro lithotypes and macerals in coal, Proximate and Ultimate analysis.

Unit 2:

Coal Bed Methane (CBM) - introduction, reservoir properties, storage and transport. Underground coal gasification and liquefaction.

Unit 3:

Chemical composition and physical properties of petroleum.Origin and migration of oil.Properties of reservoir rocks.Drilling methods.

Unit 4:

Reservoir rocks - clastic and chemical., hydrocarbon traps - structural, stratigraphic and combination, Cap rocks - definition and general properties.

Unit 5:

Gas Hydrates. Radioactive minerals: Occurrence and origin of Uranium and Thorium bearing minerals, reserves in India. Nuclear waste disposal.

Course Code: GEOL DSE-1B (i) P
Course Name: Practical on Fuel Geology
Credit – 2; Full Marks – 50, Pass Marks – 20

Study of hand specimens of coal. Reserve estimation of coal. Section correlation and identification of hydrocarbon prospect. Panel and Fence diagrams.

Suggested readings:

- Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.
- Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
- Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
- Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press.

B. Sc. Three Years (Six Semesters) Course
Under
Choice Based Credit System
SKILL ENHANCEMENT COURSE

Field Work-I

Course Code: GEOL (SEC) –309

Course Name: Basic field training

Credit: 4, Full Marks – 100, Pass Marks - 40

Orientation of Topographic sheet in field, marking location in toposheet, Bearing (Front and back). Concepts of map reading, Distance, height and pace approximation. Identification of rock types in field; structures and texture of rocks, Use of hand lens. Basic field measurement techniques: Bedding dip and strike, Litho-log measurement. Reading contours and topography.

Field Work-II

Course Code: GEOL (SEC) -409(i)

Course Name: Precambrian Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Field transect in any Precambrian terrain. Study of craton ensemble including basic intrusive suites. Precambrian sedimentary basin. Basement-Cover relation in old belts and sedimentary successions.

or

Field Work-II

Course Code: GEOL (SEC) -409(ii)

Course Name: Tertiary Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Field training along Tertiary terrain. Documentation of stratigraphic details in the field. Collection of sedimentological, stratigraphic and structural details.

or

Course Code: GEOL (SEC) -409(iii)

Course Name: Economic Geology field

Credit: 4, Full Marks –100, Pass Marks - 40

Module I

Visit to any mineral deposit. Mode occurrence of ore and ore mineralogy. Ore formation process. Basic techniques of surveying, concept of outcrop mapping.

Module 2

Visit to underground or open cast mine. Practical experience of mining methods. Underground mapping/ Bench mapping.