PROGRAMME: BACHLOR OF SCIENCES (GENERAL) **SUBJECT: GEOLOGY**

SEMESTER	COURSE CODE	TYPE OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY	PRACTICAL 2 or 0	TUTORIAL 2 or 0
I	GL-DSC-21101	**DSC-1 (6 credits)**	Fundamentals of Geology	**4**	**2**	**-**
II	GL-DSC-21201	**DSC-2 (6 credits)**	Crystallography and Petrology	**4**	**2**	**-**
III	GL-DSC-21301	**DSC-3 (6 credits)**	Sedimentology and Stratigraphy	**4**	**2**	**-**
IV	GL-DSC-21401	**DSC-4 (6 credits)**	Geochemistry, Geophysics and Hydrogeology	**4**	**2**	**-**
V	GL-DSE-21501	**DSE (6 credits)**	Structural Geology /Plate Tectonics	**4**	**2**	**-**
	GL-DSE-21502	**DSE (6 credits)**	Engineering and Environmental Geology	**4**	**2**	**-**
	GL-DSE-21503	**DSE (6 credits)**	Oceanography and Marine Geology	**4**	**2**	**-**
	GL-DSE-21504	**DSE (6 credits)**	Isotope Geology and Geochemistry	**4**	**2**	**-**
VI	GL-DSE-21601	**DSE (6 credits)**	Economic Geology	**4**	**2**	**-**
	GL-DSE-21602	**DSE (6 credits)**	Remote Sensing and Societal Geology	**4**	**2**	**-**
	GL-DSE-21603	**DSE (6 credits)**	Mining and Mineral Exploration	**4**	**2**	**-**
	GL-DSE-21604	**DSE (6 credits)**	Research Project in Geosciences (Dissertation)	**0**	**0**	**6**

SKILL ENHANCEMENT COURSES: 4 Credits

(Note: students opting for the subject as a core may or may not opt for any of the skill courses related to the subject)

SEMESTER	COURSE CODE	TYPE OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY	PRACTICAL 2 or 0	TUTORIAL 2 or 0
III	GL-SEC-21301	**SEC**	Megascopic and microscopic techniques in identification of minerals	**2**	**-**	**-**
	GL-SEC-21302	**SEC**	Earth Science Work Experience	**-**	**-**	**2**
VI	**DMC419S**	**SEC (4 Credits)** (COMPULSORY)	DISASTER MANAGEMENT COURSE (Compulsory)	**2**	**-**	**2**
	GL-SEC-21401	**SEC**	Optics and optical mineralogy	**2**	**-**	**-**
V	GL-SEC-21501	**SEC**	Climate Change: Past, Present, and Future	**2**	**-**	**-**
	GL-SEC-21502	**SEC**	Environmental Sanitation	**2**	**-**	**-**
	GL-SEC-21503	**SEC**	Geotechnology	**2**	**-**	**-**
VI	GL-SEC-21601	**SEC**	Gemmology and Gem Testing	**2**	**-**	**-**
	GL-SEC-21602	**SEC**	Medical Geology	**2**	**-**	**-**
	GL-SEC-21603	**SEC**	Oil Field Services	**2**	**-**	**-**

Head of the Department
/Convener BOUGS

BACHLOR OF SCIENCE (GEOLOGY)

1st SEMESTER

DISCIPLINE SPECIFIC COURSE -1 (CORE-1)

GL-DSC-21101: FUNDAMENTALS OF GEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The study of this course will strengthen student's knowledge with respect to understanding the essentials of the structural dynamics of the earth. The students will understand the origin of our solar system and planets, including earth. The students will understand the different surface processes and geomorphogical features and their development. Besides, studying the basics of mineralogy will help the students in understanding and building the overall knowledge in Geology.

CREDIT-1 (15 HOURS)

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

CREDIT -2 (15 HOURS)

Introduction to rocks and minerals: Rocks as natural mineral aggregates; types of rocks: igneous rocks; sedimentary rocks; metamorphic rocks. Preliminary knowledge about the most common rock forming and economic minerals. Structure of earth: physical properties. Geology as the history of Earth: How the rocks record history – (a) Fossils (b) Mineralogy and the texture; (c) Structures; (d) Palaeogeography, Paleoclimate. Surface relief of the earth. Exogenous and endogenous processes. Various Geospheres.

CREDIT -3 (15 HOURS)

Fundamental concepts: Catastrophism, uniformitarianism, cycle of erosion, and base level of erosion. Weathering: definition and types, agents of weathering. Products of weathering. Epeirogenesis and orogenesis. Mountains and types. Volcanoes: types, distribution and eruptional features. Glaciers: Definition and types, snowline, glacial movements and crevasses. Geological work of glaciers: Erosion and deposition. Aeolian processes: erosional and depositional features. Geological work of river: erosional and depositional features. Drainage patterns. Karst topography: Surface and sub-surface features. Structural landforms: Definition and types, Inversion of topography. Climate and landforms. Soils: Soil formation, Soil profiles. Oceans: Topography of sea floor. – Continental shelves, slope, abyssal plains, Ocean ridges and, submarine valleys, canyons, deep-sea trenches and guyots. Oceanic erosion and deposition. Coral reefs and types.

CREDIT -4 (15 HOURS)

Mineralogy: Definition, scope and classification of silicate minerals and ore forming minerals. Scalar and vector properties of minerals. Moho's scale of hardness. Physical properties and mode of occurrence: Quartz, Feldspar, Mica, Amphibole, Pyroxene, Olivine, Garnet, Chlorite, and Carbonate. Optical Mineralogy: Polarizing microscope, mechanism of polarization and interference of light, use of accessory plates. Elements of optics, isotopic medium, anisotropic medium, refractive index, Snell's law of critical angle, Optical indicatrix: isotropic, uniaxial and biaxial. Pleochroism and Birefringence. Optical properties of minerals under plane-polarized and cross-polarized light: Forms, cleavage, fractures and parting, refractive index and relief, Becke line and its use.

PRACTICAL (2 CREDITS: 60 HOURS)

MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Field Work: Study of landforms, erosional and depositional features. Handling of Clinometer and Brunton compass for ,measuring dip and strike, and plotting of field data on toposheets.

Mineralogy: Study of the physical properties of important rock-forming minerals as included in the theory paper. Study of optical properties of important rock forming minerals as included in the theory paper.

Suggested Readings:

Berry & Mason, 1988: Mineralogy.CBS Pub.

Burbank, D. W. and Anderson, R.S., 2001: Tectonic Geomorphology Blackwell Sciences

Dexter Perkin: Minerals in Thin Sections

Gribble, D. D., 1988: Rutley's Elements of Mineralogy, DBS Publications.

Holmes, A., 1996: Principles of Physical Geology, EUBS, Chapman.

Judson, S. and Kaufman, M. E., 1990: Physical Geology, Prentice Hall.
Kerr, P. F., 1984. Optical Mineralogy.
Lutgens, F. K. and Tarbuck, E. J., 1998: Essentials of Geology, Prentice Hall.
Phillips, Wm, R. and Griffen, D.T., 1986: Optical Mineralogy. CBS Edition.
Press, F. and Seiver, R., 1989: The Earth, W. H. Freeman.
Putnis, A., 2001: Introduction to mineral Science. Cambridge University Press.
Read, H. H., 1986: Rutleys Elements of Mineralogy.
Richard, V. G., 1997: Dana's new Mineralogy. John Wiley.
Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers,
Tarbuck, E. J. and Lutgens, F. K., 1997: Earth Science, Prentice Hall.
Terrly, G. W., 1958: Principles of Petrology, Mathuen.
Vishwas, S. K and Gupta, A., 2001: Introduction to Geomorphology Orient Longman.

BACHLOR OF SCIENCE (GEOLOGY)

2nd SEMESTER

DISCIPLINE SPECIFIC COURSE -2 (CORE-2)

GL-DSC-21201: CRYSTALLOGRAPHY AND PETROLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The course will help the students to exhibit an improved understanding of crystallography and fundamental petrologic processes and common rock types. The students will gain an understanding of the processes involved in the formation of igneous and metamorphic rocks, their textures, structures, classifications and their importance. The students will also learn to identify, describe and classify rocks using hand specimens and under petrological microscope.

CREDIT -1 (15 HOURS)

Crystallography: Introduction, and Morphology of crystals: Face, edge and solid angle, interfacial angle and Law of constancy of interfacial angles. Description of Laws governing the crystallography. A brief idea of Symmetry and Lattice: Bravias Lattices, symmetry operations, Crystal Systems, crystal forms, crystal classes. Axial system and axial ratios. Parameter system of Weiss, Miller indices. Law of Rationality of indices. Translation vectors, planar and space lattices. Crystal growth and twining: Growth of crystals from melt and solutions, and twining in crystals: Types, causes and laws, Normal class of crystal systems. Crystal forms: Crystallized, crystalline, cryptocrystalline and amorphous. Crystal habit: elongated, tabular, flattened and equant. Description of form of crystalline and cryptocrystalline aggregates. Crystal chemistry: Dimorphism, polymorphism, pseudomorphism, isomorphism and solid solution.

CREDIT -2 (15 HOURS)

Nature and scope of petrology: Difference between Petrography and petrogenesis. Structure of igneous rocks: Large structures- blocky lava, amygdaloidal lava, and vesicular structures, pillow structures, flow structures, sheet and platy structures, prismatic and columnar structures. Textures: Crystallinity, granularity (phaneric and aphanitic), shapes of crystals, mutual relations of crystals, equigranular and unequigranular textures, porphyritic, poikilitic, opthitic, intersertal and

intergranular textures, directive textures, intergrowth textures. Reaction textures. Reaction structures – corona and kelyphitic borders.

CREDIT -3 (15 HOURS)

Classification of igneous rocks: Principles of classification, CIPW classifications, IUGS classification and tabular classification. Nomenclature and description of common igneous rocks

Composition and constitution of magma: Definition of magma, composition of magma, types of magma, physico-chemical constitution of magma, primary magma. Processes resulting in diversity in igneous rocks: Fractionation and differentiation–Gravity settling, filter-press differentiation, flow diffusion and gaseous transfer within magma; liquid immiscibility, mixing of magmas. Assimilation.

CREDIT -4 (15 HOURS)

Metamorphic rocks: Definition of metamorphism; Controls of metamorphism–bulk composition and motivating forces in metamorphism- heat, pressure and chemically active fluids. Types of metamorphism–Contact, cataclastic, regional. Metasomatism, anataxis, palingenesis, migmatization. Metamorphic facies. Metamorphic textures and structures.

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Crystallography: Demonstration of space lattice, model-Galena, Fluorite, Sphalerite, Pyrite and Calcite. Clinographic projection of the following crystals form: Cube, Octahedron, Zircon, Beryl, Calcite and Gypsum.

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

Suggested Readings:

Berry & Mason, 1988: Mineralogy.CBS Pub.
Best, M. G., 1986: Igneous Petrology, CBS Pub.
Blatt H.& Tracy R.J. 1995. Petrology: Igneous, Sedimentary & Metamorphic. WHF & Co, New York.
Bose, M. K., 1997: Igneous Petrology. World Press.
Ehlers and Blatt, 1999: Petrology, (Igneous, Sedimentary and Metamorphic). CBS Pub.
JAK Tareen & TRN Kutty, 2001: Crytallography. Universities Press (India) Limited.
Kerr, P. F., 1977: Optical Mineralogy. McGraw Hill.
McBirney, A. R., 1993: Igneous Petrology. John Wiley.
Miyashiro, A., 1994: Metamorphic Petrology. UCL Press Ltd., London.
Phillips, Wm, R. and Griffen, D.T., 1986: Optical Mineralogy. CBS Edition.
Philpotts, A., 1992: Igneous and Metamorphic Petrology. Prentice Hall.
Putnis, A., 2001: Introduction to mineral Science. Cambridge University Press.
Richard, V. G., 1997: Dana's new Mineralogy. John Wiley.

Turner &Verhoogen, 1999: Igneous and Metamorphic Petrology. CBS Pub.
Turner, F. J., 1980: Metamorphic Petrology. McGraw Hill, New York. ‘
Tyrrell, G. W., 1987: Principles of Petrology.CBS Pub
Winter, J.D. 2010. Igneous and Metamorphic Petrology.
Yardley, B. W., 1989: An Introduction to Metamorphic Petrology. Longman, New York.

BACHLOR OF SCIENCE (GEOLOGY)

3rd SEMESTER

DISCIPLINE SPECIFIC COURSE -3 (CORE-3)

GL-DSC-21301: SEDIMENTOLOGY AND STRATIGRAPHY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The students will gain an understanding of the processes involved in the formation of sedimentary rocks, their textures, structures, classifications and their importance. The study of stratigraphy and Palaeontology encompasses the aspects of the age of the earth, chronological arrangement of rocks and appearance and evolution of life through the geologic time. The knowledge of the concepts in stratigraphy, correlation, and paleontology would enable the students to understand the changes that occurred in the history of the earth and relate them to their field observations and also, in understanding the framework of the stratigraphy of India. The students will be exposed to the principles of stratigraphy including order of superposition. They will also be able to identify primary sedimentary structure and their depositional environments. Upon completion of this course, students will be able to identify sedimentary rocks and their depositional environments with stratigraphic sequence and their paleontological aspects.

CREDIT -1 (15 HOURS)

Sedimetary rocks: Process involved in formation of sedimentary rocks: erosion, transportation, deposition, diagenesis and lithification. Texture: size, roundness, sphericity, surface texture fabric, porosity and permeability. Gran size analysis, grade scale, sieving method: types , use and methods. Sedimentary Structures: Primary, secondary and biogenic. Major primary structures: cross bedding, cross lamination, horizontal bedding, graded bedding, sole marks, ripple marks, rain prints and dunes. Classification of clastic and non clastic rocks: Rudaceous, Arenaceous, Argillaceous and calcareous.

CREDIT -2 (15 HOURS)

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

of preservation and occurrence. Application of Paleontology. Evolution of Man, Horse & Elephant. Morphology characters, geological, geographical and stratigraphic distribution of the following: (1) Brachiopoda (2) Bivalvia (3) Gastropoda (4) Cephalopoda (5) Graptoloida (6) Anthozoa (7) Echinoidea (8) Trilobita. Introduction to micropaleontology and microfossils and their application.

CREDIT -3 (15 HOURS)

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

CREDIT-4 (15 HOURS)

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

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

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

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

Suggested Readings:

Arnold, C. A., 1947: An introduction to Paleobotany. McGraw - Hill Book Co.
Bignot, G., 1985: Elements of Micropaleontology. Graham andTrotman.
Brasier, M. D., 1980: Microfossils. George Allen &Unwin.
Collinson, J. D, 1999: Sedimentary Structures. Springer Verlag.
Einsele, G., 1992: Sedimentary Basins. Springer Verlag.
Friedman, G. M. and Sander, J. E., 1978: Principles of Sedimentology. John Wiley.
Krishanan, M. S., 1968: Geology of India and Burma. HigginbothamsPvt. Ltd., Madras.

Kumar, R, 1998: Fundamentals of Historical Geology and Stratigraphy. Wiley Eastern Limited.
Miall, A. D., 1999: Principles of Sedimentary Basin Analysis. Springer-Verlag.
Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: Sand and Sandstone. Springer Verlag.
Reading, J. G. 1996: Sedimentary Environment and Facies. Black well.
Selley, R. C., 1976: Introduction of Sedimentology. Academic Press, London.
Selley, R. C., 1976: Introduction of Sedimentology. Academic Press, London.
Sengupta, S., 1997: Introduction to Sedimentology. Oxford-IBH.
Sengupta, S., 1997: Introduction to Sedimentology. Oxford-IBH.
Shork&Twenholf, 1987: Principles of invertibratePaleontology. CBS Pub., N. Delhi.
Weller, J. M., 1960: Stratigraphy Principles &Practice. Harper & Row Pub.

BACHLOR OF SCIENCE (GEOLOGY)

4th SEMESTER

DISCIPLINE SPECIFIC COURSE -4 (CORE-4)

GL-DSC-21401: GEOCHEMISTRY, GEOPHYSICS AND HYDROGEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

This course deals with extracting geological information out of geochemical and geophysical datasets. The student will acquire skills to use various geochemical and geophysical methods for exploration and their significance. The geophysical techniques include seismic, gravity, magnetic and electrical resistivity methods and their various applications. The students will gain an understanding of the seismic involved in bringing the earthquakes and their impact on society. Besides, the student will understand the hydrological processes acting on and below the surface of earth.

CREDIT -1 (15 HOURS)

Introduction to geochemistry: Crystal chemistry-chemical bonds, coordination number, radius ratio, ionization potential, electro-negativity, atomic substitution, phase rule. Cosmic abundance of elements. Major element, trace elements and Rare earth elements, Large ion lithophile elements and High field strength elements. Gold Schmidt's geochemical classification of elements. Geochemical characteristics of crust, mantle and core. Geochronology and age of Earth. Relative and absolute dating techniques for age determination. Radioactivity and concept of half-life, decay constant, natural radioactive isotopes.

CREDIT -2 (15 HOURS)

Introduction and scope of geophysics, Spheroidal shape of earth and Geoid, magnetic field of the earth, paleomagnetism, Exploring Earth's interior with geophysical techniques. Applications of geophysics in mineral and energy resources exploration. Earth's thermal history: Heat conduction and heat flow. Thermal gradient of the earth. Convection currents-evidence and models. Gravitational Field: Concept, its variability with latitude, altitude, topography, and subsurface density variations. Gravity instruments: Pendulum gravimeters, Ship borne measurements. Units of gravity, gravity anomaly - definition, types (Free- air, Bouguer), local and regional concepts.

Detection of cavities at engineering sites. Isostasy: Observation; Pratt and Airy schemes of the isostatic compensation, elastic crust on viscous mantle.

CREDIT -3 (15 HOURS)

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

CREDIT -4 (15 HOURS)

Hydrosphere: Distribution of water: Saline water and fresh water. Forms and origin of water. Surface water (hydrology) and subsurface water (soil water and ground water). Porosity: Primary and secondary: specific yield and specific retention. Aquifer, aquitard, aquiclude, aquifuge. Types of aquifers: unconfined, confined and perched aquifers. Hydraulic conductivity and storativity. Darcy's Law, Understanding the transport and purification of water through Hydrological cycle. Physico-chemical quality of water (pH, EC, Ca, Mg, Na, K, Cl, HCo_3, So_4, No_3).

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Seismology: Earthquake location: Focus, epicenter and hypocenter; Earthquake belts on earth.
Hydrogeology: Delineations of hydrological boundaries on water table contour maps and estimation of aquifer properties as hydraulic conductivity. Storage coefficient and Transmissivity.

Books Recommended:

Albarede, F., 2003: Geochemistry - An Introduction, Cambridge.
Bhimasarikaram V.L.S., (1990) Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.
Dobrin, M B and Savit C H. (1988) Introduction to Geophysical Prospecting, McGraw Hill Inc.
Gunter, F., 1991: Principles and Applications of Inorganic Geochemistry, Prentice Hall.
Karanth, K. R., 1987: Groundwater assessment, Development and Management, MG. Hill.
Lowrie, W., (2007) Fundamentals of Geophysics. Cambridge University Press.
Marshal, C. P. & Fairbridge, R. W., 1999: Encyclopaedia of Geochemistry, Kluwer Acadmic.
Moore M. (1982) Principles of Geochemistry, Wiley.

McCalpin, J. C., 1996. Field techniques in palaeoseismology. Palaeoseismology, Academic Press, London, p. 588.
McCalpin, J., 2009. Paleoseismology. Second Edition: San Diego, Academic Press, p. 613.
Parasnis D. S. (1986): Well Logging in Oil Fields, In: Principles of Applied Geophysics, Springer.
Raghunath H.M. (2003) Groundwater, New age education.
Ramachandra Rao and Prasaranga, M B. (1975) Outlines of Geophysical Prospecting - A Manual for Geologists by University of Mysore, Mysore.
Telford, W. M., Geldart, L. P., and Sheriff, R. E., (1990) Applied geophysics (vol. 1). Cambridge University Press.
Todd, D. K., 1980: Groundwater Hydrology, John Wiley.
William, L., 1998: Introduction to Geophysics, Cambridge.

BACHLOR OF SCIENCE (GEOLOGY)

5th SEMESTER

DISCIPLINE SPECIFIC COURSE -5 (CORE-5)

GL-DSC-21501: STRUCTURAL GEOLOGY/PLATE TECTONICS

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The course deals with geological structures resulting from the action of these forces on rocks. The student will gain knowledge of the geometry of the rock structures, understand the mechanism of the evolution of rock structures and its application in the field. The students learn the skills of identifying different structure and measurements using Brunton compass. This is fundamental to geological mapping. This course also helps to know how to use structures and help students appreciate the dynamic nature of the Earth lithosphere. Learn how to read geologic maps and solve simple map problems using strike and preparations of cross sections.

CREDIT -1 (15 HOURS)

Basic concepts of field geology: Maps–definition, topographic and geological maps. Dip and strike of stratified rocks, True dip, apparent dip, plunge and pitch of linear structures. Outcrop patterns. True thickness and vertical thickness. Width of the outcrop, relation between true thickness and the width of outcrop. Criteria for distinction between normal and overturned sequences: ripple marks, cross bedding, graded bedding, mud cracks, rain-imprints, Pillow lava, vesicular tops of lava beds, Relationship of cleavage with bedding, Paleontological methods.

CREDIT -2 (15 HOURS)

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

CREDIT -3 (15 HOURS)

Faults: Definition, terminology and classification (geometrical). Criteria for recognition of faults: discontinuity of structures, repetition and omission of strata, features characteristic of fault plane: slickenside, gouge, fault breccias, mylonites, silicification and mineralization, differences in sedimentary facies. Physiographic criteria: scraps, triangular facets. Offset streams. Mechanical principles: Stress; definition of force and stress. Normal and shear stress. Basic concept of stress ellipse. Strain definition and computation of changes in line length. Basic concept of strain ellipse.

CREDIT -4 (15 Hours)

Important concepts about Earth dynamics: outline description of Contraction, Expansion, Plate tectonic models. Plate tectonics - basic concepts and definitions, types of plate margins, important characters of plate margins. Mechanism of plate movement; Mantle plumes vis-à-vis island chains. Plate tectonics in relation to the distribution of seismic, volcanic and island arc belts. Plate tectonic models for the origin of mountain belts: Ocean-ocean, ocean-continent, Continent-Continent types of convergent boundaries. Northward movement of the Indian Plate and the origin and evolution of the Himalayas and its thrust belts. Seismicity of the Indian subcontinent

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Study of contours and landforms; Strike, true dip and Apparent dip problems; Measurement of thickness and width of outcrops; Completion of outcrops in geological maps; and drawing of profiles and study of geological maps.

Suggested Readings:

Billings, M.P., (1972) Structural Geology. Prentice Hall.
Condie, K. C., 1997: Plate Tectonics and Crustal Evolution, Butterworth & Heimnemann.
Cox, A., 1996: Plate Tectonics. Blackwell Science.
Davis, G.R., (1984) Structural Geology of Rocks and Region. John Wiley
Hills, E.S., (1963) Elements of Structural Geology. Farrold and Sons, London.
Jain, A.K., (2014) An introduction to structural geology. Text Book series in Geological Sciences for Graduate Students. Geological Society of India, Bangalore.
Keary, P. and Vine, F. J., 2000: Global Tectonics, Blackwell Science.
Ramsay, J.G. (1967) Folding and fracturing of rocks. McGraw-Hill, New York
Singh, R. P., (1995) Structural Geology: A Practical Approach. Ganga Kaveri Publ., Varanasi
Subramanian, V., 2001: Text Book on Environmental Science, Narosa International.

GL-DSE-21502: ENGINEERING AND ENVIRONMENTAL GEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The students will learn the skills of identifying and mapping of different geolofical structures and alignment of engineering projects and their environmental effects. This course will also help students to comprehend the dynamic nature of the Earth lithosphere. Besides, reading geologic maps and solve simple map problems using strike and preparations of cross sections useful in the engineering projects are also the focus of the course. Moreover, the students will also learn the different environmental aspects of engineering projects.

CREDIT -1 (15 Hours)

Basics of Engineering Geology,

Basics of Engineering Geology: Engineering properties and classification of rocks. Factors affecting engineering properties of rocks. Importance of geological studies to Engineers and significance of geological Investigations for civil engineering projects. Rock stability tests. Engineering properties of soils.

CREDIT -2 (15 Hours)

Geology for Site selection and construction of roads, buildings, dams, bridges, Tunnels, and reservoirs. Mass movements. Earthquakes, Soil liquefaction, creep and seismic zones of India.

CREDIT -3 (15 Hours)

Environmental Geology. Soils: soil formation, types of soils, soil degradation. Environmental changes due to influence of humans. Explain the causes of soil, air and water pollution.

CREDIT -4 (15 Hours)

Surface processes and erosion. Deforestation and land degradation. Geology of Mineral Resources, Mineral Resources and the Environment. Minerals and Human Use, Waste disposal, Waste Management and Geology.

Suggested Readings:

Arms, k., 1990: environmental science. Saunders college pub.
Bell, f. G., engineering properties of soils and rocks.
Bell, f. G., 1999: geological hazards their assessment, avoidance & mitigation. E&fn s. London.
Bell, f. G., 1999: geological hazards. Routledge, london.
Bryant, e., 1985: natural hazards. Cambridge university press.
Goodman, r. E., engineering geology.
Keller, e. A., 1978: environmental geology. Bell and howell, usa.
Krynine, d. H. And judd, w.r., 1998: principles of engineering geology. Cbs pub.
Lanen, f., environmental geology.
Lawrence, l. Environmental geology.
Lundgren, l, 1986, environmental geology. Prentice hall.
Michael, a., basic of environmental science.
Parasnis, d. S., 1975: principles of applied geophysics. Chapman hall.
Pipkin, b. W. & trent, d. D., 1997: geology and the environment. West wardsworth.
Singh, a., modern geo-technical engineering.
Smith, k., 1992: environmental hazards. Rutledge, london.
Valdiya, k. S., 1987: environmental geology -indian context. Tata mcgraw hill.
Venkat, r. D., engineering geology for civil engineers.
Waltham, a. C., 1997: foundations of engineering geology. Blackie academic & professional.
Subramaniam, v., 2001: textbook in environmental science-narosa international

GL-DSE-21503: OCEANOGRAPHY AND MARINE GEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

(i) Course learning outcome:

A student will understand and learn about the basic concepts of oceanography and marine geology with respect to geology as to enable them to work as a marine researcher.

(ii) Broad contents of the course:

To provide essential concepts of oceanography and to study the tectonics, geology, economic resources with respect to the oceans.

(iii) Skills to be learned:

The students will equip himself with knowledge and skills related to dealing with the physical and chemical components and phenomena related to oceanography and marine geology.

(iv)The detail contents of this course and references and suggested books:

Physical oceanography, ocean salinity, ocean currents (6), El-Nino-La Nino effect relation between climate and ocean in the Indian context(6), Exclusive economic zones and their economic potential(5), Principles behind echo sounder and side scan sonar systems (5) and seismic methods(6), Physiographic divisions of oceans(5), Origin, stricter and evolution of Indian Ocean shelf and margins (estuaries, deltas, tidal flats)(6). Approach to be interdisciplinary requiring integration of biological, chemical, physical and geological processes (6). Past historical impact of sea level changes (5), coastal erosion and conservation methods (5), Coastal Regulatory Zones(5).

Books Recommended:

Dronkers J. (2005) Dynamics of coastal systems, World Scientific
Einsele, G. (1982) Sedimentary basins-evolution, facies and sediment budget. Springer-Verlag.
Fowler, C.M.R. (1993) The Solid Earth, Cambridge Press University.
Kenneth, J. (1982) Marine Geology and Geophysics.
Nittrouer, C.A., Austin, J. A., Field M. E., Kravitz J. H., SyvitskiJ. P. M., Wiberg P.L.(2007) Continental margin, sedimentation from sediment transport to sequence stratigraphy, Wiley Blackwell.
The Open University (1989) Ocean chemistry and deep sea sediments.
Tuscot, D.L. and Schubert, G (1992) Geodynamics, Wiley and Sons.
Woodroffe, C.D. (2013) Coast: Form, process and evolution, Cambridge University Press.
Wright J. and Colling A. (1995) Seawater: its Composition, Properties and Behaviour, The Open University.

GL-DSE-21504: ISOTOPE GEOLOGY AND GEOCHEMISTRY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

(i) Course learning outcome:

The course provides a forum to introduce the concept of isotopes to graduate students and the use of radiogenic and stable isotopes in geosciences.

(ii) Broad contents of the course:

Radiogenic and stable nuclides are a critical tool for dating materials, understanding planetary differentiation, and tracing provenance and process in all spheres of the earth. This course examines the theory and application of isotope geochemistry to a broad range of geologic topics.

(iii) Skills to be learned:

At the end of the course the students will be appraised about the world of isotopes amd their use in dating or geochemical tracing. 55 UGC Document on LOCF Geology

(iv)The detail contents of this course and references and suggested books:

Radiometric isotope techniques (dating and geochemical tracing) are introduced (5) through a discussion of atoms, isotopes, and radioactive decay systematic(10), followed by systematic discussion of a number of specific systems e.g., Rb-Sr, uranium-lead, etc. (15). Applications of stable isotopes to investigating volcanism (5), metamorphism (5) and meteoric-hydrothermal systems (5) are discussed. Concepts of mass-balance, mixing theory, and open and closed systems are introduced (15).

Books Recommended:

Allegre CJ, (2008) Isotope geology, Cambridge university press
Dickin Alan P, (2005) Radiogenic isotope geology (2nd edition), Cambridge University Press.
Faure G. and Mensing T, (2005) Isotopes: Principles and applications (3rd edition), John Willey
Hoefs Jochen, (2015) Stable isotope geochemistry (7th edition), Springer
Moore M. (1982) Principles of Geochemistry, Wiley.
Schaefer Bruce F, (2016) Radiogenic isotope geochemistry, Cambridge University Press.
White William M, (2014) Isotope geochemistry, Willey-Blackwell

BACHLOR OF SCIENCE (GEOLOGY)

6th SEMESTER

DISCIPLINE SPECIFIC COURSE -6 (CORE-6)

GL-DSC-21601: ECONOMIC GEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

They will also get familiarized about the processes involved in the formation of various ore minerals. The students will be appraised about the origin, migration and accumulation of petroleum; it will also provide basic skills in prospecting, drilling and logging operation in oil exploration. Besides, the students will also learn about the process involved in the formation of coal and its various types.

CREDIT -1 (15 HOURS)

Ore minerals and gangue. Concept of metallogenic Epochs and provinces. Classification of minerals deposits – genetic and associational parameters. Magmatic deposits; Hydrothermal deposits with reference to: a) Porphyry copper deposit b) Vein deposits of tin and tungsten. Formation of pegmatite and pegmatite deposits in India.

CREDIT -2 (15 HOURS)

Oceanic mineral resources (manganese nodules). Ores formed by metamorphic processes. Supergene enrichment deposits. Placer & residual deposits. Mode of occurrence of following minerals deposits in India: Banded iron formation, Gold, Thorium, Mica, Bauxite and Tungsten deposits.

CREDIT -3 (15 HOURS)

Origin of Petroleum – Organic versus inorganic theories, transformation of organic matter into petroleum (geochemical aspects, pressure, temperature, depth of occurrence). Limiting conditions of petroleum occurrence. Reservoir rocks – definition and types. Source rocks; definition and types. Migration and accumulation of petroleum: primary and secondary migration.

CREDIT -4 (15 HOURS)

Reservoir Traps, classification (structural, stratigraphic). Cap rocks – types. Coal; Introduction; Constituents of coal: Rank and grade of coal; Varieties of coal (physical and chemical characters); Origin of coal. Distribution of Coal in time and space.

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

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

Suggested Readings:

Evan, A. M., 1983: Ore Geology and industrial Minerals. Blackwell.
Guillemot, J., 1986: Oil and Gas Exploration Techniques. Additions Technip.
Holson, G. D. and Tiratsoo, E.N., 1985: Introduction Petroleum Geology. Gulf Pub.
Jensen, M. L. and Bateman, A. M., 1981: Economic Mineral Deposits, John Wiley.
Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub.
Landon, R. C., 1996: Principles of Petroleum Development Geology. Printice Hall.
Prasad, U., 1996: Economic Geology. CBS Pub. N. Delhi.
Salley, R. C., 1988. Elements of Petroleum Geology. Academic Press.
Sinha, R. K. and Sharma, N. L. 1993: Mineral Economics. Oxford & IBH Pub. Co. Pvt. Ltd. Stach, E. and Others, 1982: Stach's Text Book of Coal Petrology.
Tissot, B. P. &Welte, D. H., 1984: Petroleum Formation and Occurrence, Springer Verlag.

GL-DSE-21602: REMOTE SENSING AND SOCIETAL GEOLOGY

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

Objective/Expected learning outcomes:

The course is meant to address the fundamental techniques used for remote sensing. At the end of this course, the student will be appraised with all the theoretical knowledge, information and skills to use remotely sensed data for geological applications.

This course intends to introduce students to the fundamental principles and techniques of remote sensing, basic properties of electromagnetic radiation and its interaction with matter, It will also include topics like instruments and platforms used for remote sensing, and the ways those systems can be used to determine geological structure and rock types. After completion of this course, the

student will be well versed with the world of remote sensing and the applications and interpretation of data related to geosciences.

CREDIT -1 (15 HOURS)

Remote sensing: Concept and foundation of RS (Electromagnetic spectrum, radiation laws). Overview of RS technology. Landsat, IRS, SPOT, MODIS. Introduction to Microwave remote sensing and its applications. Interaction of Electromagnetic waves with Earth surface features (water, soil, rocks, and vegetation).

CREDIT -2 (15 HOURS)

Photo-geology and its applications. Spectral behaviour of different soils. Mapping of soil - eroded and non-eroded soil and degraded lands. Application of remote sensing: geomorphological mapping, land use/land cover mapping. Introduction to GIS and its applications. Digital terrain analysis using DEM data: Path analysis, network applications and morphometry; Introduction to GIS models and modelling.

CREDIT -4 (15 HOURS)

Societal Geology: Fundamental concept (environment, population needs and planning). Natural Hazards: Landslides: Slope stability, causes of landslides, anthropogenic activity and landslides, prevention and correction of landslides. Landslide hazard mapping.

CREDIT -3 (15 HOURS)

Earthquakes; Scale of intensity related damage, preventive measures. Seismic hazard zonation. Floods: magnitude and frequency of floods, urbanization and flooding, nature and extent of flood hazard. Coastal hazards: tropical cyclones, tsunamis and coastal erosion

PRACTICAL (2 CREDITS: 60 HOURS)
MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Tutorial on different modules of image processing software; Import and export of satellite data; Different image and remote sensing data formats; Familiarization with the earth surface features on the images; Pre-processing of satellite data like image registration, geo-correction, filtering, image enhancements; Image ratios and its uses, land use/land cover feature identification.

Suggested Readings:

Bell, F.G., 1999.Geological Hazards-Routledge, London.
Bryant, E., 1985.Natural Hazards-Cambridge University Press.
Burrough, P.A., 2003: Principles of Geographic Information Systems. Oxford University Press.
Campbell, J., 2002. Introduction to Remote Sensing.Guilford Press, New York.
Demers, M. N., 1999. Fundamentals of Geographic Information System. John Wiley.

Edward A. Kellerand Duane E. DeVecchio, 2011.Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes (3rd Edition).
Jensen, J. R., 2004: Remote Sensing of the Environment. Prentice Hall, New Jersey.
John, A. Richards, 1993: Remote Sensing Digital Image Analysis. Springer-Verlag.
John, R. Jensen, 2000: Introductory Digital Image Processing, A Remote Sensing Perspective.
Lillesand, T. M. and Kiefer RW., 1987. Remote sensing in Geology. J. Wiley. Prentice Hall.
Lillesand, T. M. and Kiefer RW., 2002. Remote sensing and Image Interpretation. John Wiley.
Sabbins, F. F., 1985: Remote Sensing - Principles and Applications. Freeman.
Wiley Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge University Press.

GL-DSE-21603: MINING AND MINERAL EXPLORATION

CREDITS: THEORY-4, PRACTICAL-2

THEORY (4 CEDITS: 60 HOURS) MAXIMUM MARKS: 60, MINIMUM MARKS: 24

(i) Course learning outcome:

The course provides the student essential and basic concepts of mineral expiration techniques and the art and science of mining mineral resources.

(ii) Broad contents of the course:

The curse envisages to expose the students to the topics such as geology in mining industry, methods of exploration, Sampling Principle, Methods, estimation of reserves, Ore Dressing and Beneficiation.

(iii) Skills to be learned:

This course tries to impart skills related to Geology in mining and enable him/her to perform duties of a geologist at the mining site.

(iv)The detail contents of this course and references and suggested books:

Geology in mining industry, Tenor and Grade: definition, meaning and specification (5), mineral exploration: sequence and phases, methods of exploration (5), float ores and In situ ores, Gossan (4), Pits, Trenches and Boreholes, core drilling, equipment and accessories, Core drill sampling, core splitting, logging, storage, sludge, combining Assay returns from sludge and core (10). Calculation of Specific gravity, Porosity, Bulk density, compression factor(5), Sampling Principle, Methods, Size and quantity, Reduction, Errors, Sampling practices in open-cast mining (5).

Categories of reserves, estimation of reserves, cross-sectional method, area of influence method, triangular method, and weighted volume estimate method (8), Classification of mining methods, Factors influencing choice of mining method, Open cast mining, Underground mining, Coal mining methods (10), Ore Dressing or Beneficiation (4), Brief outline of Mining Acts and Regulations in India, Conservation of mineral resources (4).

Books Recommended:

Arogyaswamy R.N.P. (1973) Courses in Mining Geology, Oxford and IBH Publishers Co. Ltd., 916 pages.

Babu S. K. and Sinha D. K.(1988)Practical Manual of Exploration and Prospecting, CBS Publishers and Distributors, New Delhi.

Dobrin, M. B. (1960) Geophysical prospecting, McGrath Hill.

Evan, A. M., 1983: Ore Geology and industrial Minerals. Blackwell.

Jensen, M. L. and Bateman, A. M., 1981: Economic Mineral Deposits, John Wiley.

Keller, S. E., 1994: Mineral Resources, Economic and the Environment. McMillan College Pub.

Krieter, V. M. (2004) Geological prospecting and exploration, University Press of Pacific.

Levarson, 1985: Geology of Petroleum. CBS Pub.

McKinstry H. E.(1980)Mining Geology, Prentice Hill Inc., 667 pages.

Prasad, U., 1996: Economic Geology. CBS Pub. N. Delhi.

Rose, Howkes and Webb (1979) Geochemistry in mineral exploration, Academic Press.

Sharma J. P.(2009) Environmental Studies, Laxmi Publications (P) Ltd, New Delhi, Indian Bureau of Mines publications.

Sinha R. K. and Sharma N. L. (1989)Mineral Economics, Oxford and IBH Publishers Co. Ltd, 4th Edition, 410 pages.

GL-DSE-21604: RESEARCH PROJECT IN GEOSCIENCES (DISSERTATION)

(Credits: 06)

(i) Course learning outcome:

To inculcate a culture of research and innovation at the undergraduate level so that the students are exposed to the nitty-gritty of the Scientific Research in their fields

(ii) Broad contents of the course:

This course is designed with great flexibility and involves the topic of interests of the students as well as his Research Supervisor or Institute where he intends to undertake the Dissertation work.

(iii) Skills to be learned:

The basic aim is to expose the students at an early stage to field and laboratory techniques and sophisticated instrumentation.

(iv)The detail contents of this course and references and suggested books:

An opportunity to work on a six month-long research project in geosciences under the direct supervision of a faculty member in University/Institute or Government Organisation. Students will develop a research proposal, carry out data collection using field and/or laboratory studies, and complete a final report/presentation. Field studies, Laboratory studies / data processing, reference work and presentation of the thesis are four major components of the course. Students opting for this course should adhere to the following procedure.

1. Precise title and outline of work is to be submitted to the Head of the Department/Exam Coordinator.
2. The student shall spend at least one week in the field. The field work shall be carried out only during vacation or holidays, and in no case student will be permitted to be absent from regular teaching on account of dissertation. The student shall maintain field diaries and other record relevant to dissertation.
3. If (s)he is working on a laboratory project, the fieldwork component may or may not be essential.
4. Every month the student shall submit the progress report and laboratory work done, through the supervisor to Head of the Department/Exam Coordinator.
5. The student shall do dissertation at his own cost. The department will not spare funds for this purpose.
6. The student shall give a seminar before the submission of the dissertation.
7. The supervisor shall submit the practical sets based on topic of dissertation developed for the students to Head of the Department/Exam Coordinator prior to the commencement of practical examination.
8. Non-compliance of any of the above rules will disqualify students for grant of terms.
9. Three copies neatly typed on thesis size paper or A4, well bound together with maps and illustrations should be submitted.
10. Dissertation, on the basis of the work carried out by the student, will be submitted, through the supervisor concerned, to the Head of the Department//Exam Coordinator before the commencement of the practical examination, for being forwarded to the Board of Examiners. In case of student receiving help (training and / or participation in ongoing research activities)from

other Institution/Organization for their dissertation work, the associated scientist from that Institute/ Organization will function as co-supervisor.

SKILL-BASED ELECTIVE COURSES (SEC)

3rd SEMESTER

GL-SEC-21301: MEGASCOPIC AND MICROSCOPIC TECHNIQUES IN IDENTIFICATION OF MINERALS

(2 Credits)

(i) Course learning outcome:

The course will enable the students to study the physical and optical properties of minerals. It will also help them to differentiate between different minerals on the basis of physical and optical properties.

(ii) Broad contents of the course:

This course is designed with great flexibility covers the basics of geoscientific studies in mineralogy. The knowledge of visual identification and optics is applied in understanding the genesis and identification of minerals.

(iii) Skills to be learned:

This course will help the students to identify minerals in thin hand specimen and thin sections- an art and science essential for fundamental research in Geology.

(iv)The detail contents of this course:

Unit-1

Mineral definition. Crystalline and amorphous substances, structure, form, fracture and cleavage, colour, luster, transparency, streak, hardness, sp.gravity, tenacity, feel, taste, odour, striations. Physical properties, chemical composition, and megascopic identification of important minerals

Unit-1

Petrological microscope and its parts. Centering of microscope for thin section studies. Preparation of thin sections. Plane polarized light, Double refraction and Snells law. Use of gypsum plate and quartz wedge in microscopic studies.

Optical properties of minerals: colour, form, cleavage, refractive index, relief, alteration, inclusions, zoning, pleochroism, isotropism and anisotropism, extinction angle, interference colours, birefringence, twinning.Microscopic study of important rock forming minerals.

Suggested Readings:

Alexander N.Winchell, 1968, Elements of Optional Mineralogy, Parts I and II, Wiley Eastern (P) Ltd.,
E.S.Dana, 1935, A Text Book of Mineralogy, John Wiley & Sons.
Ernest, E.Walhstrom, 1960, Optional Crystallography, John Wiley and Sons.
Kerr,B.F., 1995, Optical Mineralogy 5th Ed. Mc Graw Hill, New York.
L.G.Berry Mason, 1961, Mineralogy, W.H.Freeman & Co.,
S.Mitra, 1994, Fundamentals of Optical, Spectroscopic and X-ray Mineralogy, S.R.Technico Book House, Ashok Raj Path, patna.
W.A.Deer, R.A.Howie and J.Zussman, 1966, An Introduction to the Rock Forming minerals, Longmans.

GL-SEC-21302: EARTH SCIENCE WORK EXPERIENCE

(2 Credits)

(i) Course learning outcome:

The learning outcome of this work experience course is to provide the students with a glimpse of the kind of professional ethics and work culture that reputed labs and institutions demand and inculcate.

(ii) Broad contents of the course:

This course is designed with great flexibility and involves the topic of interests of the students as well as his Research Supervisor or Institute.

(iii) Skills to be learned:

After completion of this course, it is expected that the students gains skills and experience with professional ethics and work culture of reputed labs and institutions. This will help the student in his future career and enhance his employability.

(iv)The detail contents of this course:

An opportunity to learn about Earth Science through relevant employment experiences. Students must complete at least 3 weeks in part-time employment in an Earth Science position that has been approved by a faculty member in the department. Interim and final work-experience reports must be submitted.

4th SEMESTER

GL-SEC-21401: OPTICS AND OPTICAL MINERALOGY

(2 Credits)

(i) Course learning outcome:

The course will enable the students not only to differentiate minerals based on their optical properties, but also to understand how they originate and associate with each other in a rock.

(ii) Broad contents of the course:

The course covers the basics of geoscientific studies in mineralogy. The knowledge of optics is applied in understanding the genesis and identification of minerals.

(iii) Skills to be learned

This course will help the students to identify minerals in thin sections- an art and science essential for fundamental research in Geology.

(iv)The detail contents of this course and references and suggested books

Plane polarized and cross polarized light (2), Isotropic and Anisotropic minerals (2) Behavior of minerals in cross polarized light, Birefringence (2), Conoscopic or convergent polarized light(2), Uniaxial and Biaxial minerals - Uniaxial and Biaxial Indicatrises (4),Orientation of indicatrises as per the section (2), Interference of light waves, Passage of light through doubly refracting minerals (2). Optical accessories like mica, gypsum and quartz plates (6), Determination of Optic sign of uniaxial and biaxial minerals (2). True and apparent optic axial angle, 2V and 2E (4), Optical properties and identification of some common rock forming minerals (2).

Books Recommended

Kerr, P.F. (1977) Optical Mineralogy, McGraw-Hill College
E.E. Wahlstrom (1979) Optical Crystallography, Wiley, New York
Nesse, D.W., (1986) Optical Mineralogy. McGraw Hill.
W. S. Amckenzie, Guilford C. (2014) Atlas of minerals in thin section, Routledge.

5th SEMESTER

GL-SEC-21501: CLIMATE CHANGE: PAST, PRESENT, AND FUTURE

(2 Credits)

(i) Course learning outcome:

The course introduces the students to the Earth's climate system and explores the science of global climate change using different proxies.

(ii) Broad contents of the course:

Course topics include the greenhouse effects and the science of global warming and climate change impacts.

(iii) Skills to be learned:

Students should be able to describe how the Earth's climate system works and summarize general atmosphere circulation patterns, ocean circulation patterns and climate oscillations such as the El-Niño Southern Oscillation. Besides, they will also be in a position to illustrate the Earths carbon cycle and quantitatively describe how addition of CO2 to the atmosphere due to burning of fossil fuels influences the climate.

(iv) The detail contents of this course and references and suggested books:

An interdisciplinary examination of global climate change from past, present, and future perspectives. The course will review the earth's current climate system (5), investigate evidence for past climates (5), and study climate change models(5). The factors affecting the earth's climate will be examined, along with anthropogenic impacts both globally and regionally (5).Milankovich cycle (3), Greenhouse Gases and their effect. El Niño,(5) ocean circulation(2).Climate changes vis-à-vis atmospheric hazards(5), changes in rainfall patterns/intensity vis-à-vis storm surges, cyclone, floods, droughts(5). Evolution of the Indian monsoon system (5), agro-climatic divisions of Indian

subcontinent (5), Climate and landscape evolution(5). Use of climate proxies to model and motor past and present climate indicators (5).

Books Recommended:

Aguado, E., and Burt, J., 2009. Understanding weather and climate. Prentice Hall.
Bell, M. and Walker, M.J.C. (1992) Late Quaternary Environmental Change; Physical and human perspective. Longman Scientific and Technical, New York.
Bell, Martin. Late Quaternary Environmental change: Physical and Human Perspectives
Bender, M. (2013) Paleoclimate, Princeton Premiers in Climate
Bradely, R.S. (1999) Palaeoclimatology; reconstructing climates of the Quaternary. 2nd Edition Harcourt Academic Press: San Diego.
Bradley R. S.(1999) Paleoclimatology: Reconstructing climates of the quaternary. Academic Press v. 64 of International Geophysical series.
Bradley R. S., (1999), Paleoclimatology: Reconstructing climates of the quaternary. Academic Press v. 64 of International Geophysical series.
Dawson Alastair G. Ice Age Earth: Late Quaternary Geology and Climate (Physical Environment).
Lowe, J.J. and Walker, M.J.C. (1997) reconstructing Quaternary Environments Longman. ISBN 0-582-100166-2. Pp. 1-16, 148-373.
Lutgens, Tarbuck & Tasa 2009. The Atmosphere: An Introduction to Meterology. Pearson Pub.
Mathur U.B., (2010) Climate change: Past, present and future, Geol. Soc. India.
Peixoto and Oort, (1992) Physics of Climate.
Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: Sand and Sandstone. Springer Verlag.
Rohli, R.Y., and Vega, A.l., 2007. Climatology. Jones and Barlatt
Ruddiman, W.F. (2008) Earth's Climate, Past and Future, WH Freeman & Co.
Rudiman, W.F., (2001) Earth's climate: past and future. Edition 2, Freeman Publisher.
TERI, (2004) Looking back to change track, PHI

GL-SEC-21502: ENVIRONMENTAL SANITATION

(2 Credits)

(i) Course learning outcome:

The course helps students learn about sanitary and hygienic aspects in the context of Swacch Bharat programme.

(ii) Broad contents of the course:

This demand-driven and practice orientated programme brings you fundamental understanding and knowledge on urban, peri-urban and rural sanitation, especially in informal settlements.

(iii) Skills to be learned:

The course will yield graduates with fundamental understanding and knowledge, as well as the skills necessary for creating impact in the field of environmental sanitation.

(iv)The detail contents of this course and references and suggested books:

Introduction to Sanitation, Sanitation Systems and Services, Sanitation and Public Health (3), Epidemiology: Principles of protecting the environmental sanitation measures, Inspect and rodent control (4), Community sanitation measures: sanitation of camps, festivals, schools, swimming pools etc.(2) Food and milk sanitation, hotel management with reference to sanitation, food preservation, pasteurization methods and plants(2). Housing needs: lighting and ventilation, natural and artificial provisions (2) Solid wastes: characteristics, collection, disposal by landfill, composting, incineration and other methods (5). Handling and disposal of Hazardous Wastes (2), Industrial Hygiene: Occupational hazards, various operations in industrial units, Engineering and safety measures. Radiological health: radioactive wastes and disposal (3).Noise Pollution and control: Engineering and medical divisions, various programmes (2). Rural sanitation, various methods of collection and disposal of faecal matter, community toilets, septic tanks and soak pits – biogas plant. Advanced wastewater treatment and reuse (5).

Books Recommended:

Ehlers, V. M. and Steel, Ernest W. (1977) Municipal and Rural Sanitation (Sanitary Science & Water Engineering) Tata Mcgraw-hill Education.

Salvato Joseph. (2000) Environmental Engineersing and Sanitation.John Wiley & Sons Inc; 5th edition, 1562 pages.

Chanlett Emil T. (1973) Environmental Protection. Mcgraw –HillInc., US.

Linda Strande, Mariska Ronteltap, Damir Brdjanovic (2014) Faecal-Sludge-Management. IWA Publishing. https://www.un-ihe.org/faecal-sludge-management-4\.

Duggal, K.N., (2002)Elements of Environmental Engineering, S.Chand and Co., New Delhi.

Birdie, G.S. and Birdie, J.S., (1992)Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi.

Metcalf and Eddy, (2005) Waste Water Engineering, Collection, Treatment and Disposal, Tata McGraw Hill Inc., New York.

CPHEEO, (1999) Manual of Sewage and Sewage Treatment.

GL-SEC-21503: GEOTECHNOLOGY

(2 Credits)

(i) Course learning outcome:

The student will gain detail knowledge about the concepts, methods and hands on determination of soil and rock properties which will strength their knowledge of Engineering Geology. It also provides basic knowledge of surveying techniques.

(ii) Broad contents of the course:

This course deals with the Geotechnical lab measurements used in Engineering Geology. It also includes surveying and levelling methods.

(iii) Skills to be learned:

The course provides vital skills in geotechnical lab work and skills related to surveying and levelling techniques in the field.

(iv)The detail contents of this course and references and suggested books:

Geotechnical Engineering: Core logging, soil sampling (2), Determination of Water content (Oven drying and Calcium Carbide Method) (2), Sieve analysis of Soil (2), Specific Gravity by Pycnometer, Determination of Field Density by Core cutter method and Sand Replacement method (2), Determination of Consistency limit: Liquid Limit by Casagrande's Apparatus (Plastic Limit, Shrinkage Limit (2), Permeability Test (Constant Head and Falling Head method), Direct Shear Test and Vane Shear Test, Triaxial Test (4), Determination of Compaction properties of Soil by standard proctor Test, Differential Free Swell Test (2).

Surveying and Levelling: Definitions of Surveying and Levelling, Objectives of Survey (2); Measurement of horizontal and vertical angle by 1' Theodolite, Measurement of distance, angle by using Total Station (2).Definitions of Terms used in Levelling, Characteristics of a Dumpy Level and a Levelling Staff, Bench Marks, Change Points (3). Levelling operations and steps in Levelling: Demonstration with an exercise in the field (4). Principles of Levelling: Simple and Differential, Reduction of Levels: The Collimation, and Rise and Fall systems of Computation (3).

Books Recommended:

Braja M. Das (2005)Fundamentals of Geotechnical Engineering, Thomson Asia Pvt. Ltd., Singapore
Gopal Ranjan and Rao, P. (2002) Basic and Applied Soil Mechanics, New Age International Pvt. Limited, New Delhi
Kanetkar T.P. and Kulkarni S.V. (1973) Surveying & Levelling (Part I) 23rded.
Duggal, S.K. (2004) Surveying Vol. I and II, Tata McGraw Hill.
Punmia, B.C. (1994) Surveying Vol.I and II, Standard Publishers.
Arora, K. R. (1996) Surveying Vol. I and II, Standard Book House.

6th SEMESTER

GL-SEC-21601: GEMMOLOGY AND GEM TESTING

(2 Credits)

(i) Course learning outcome:

The basic idea is to make students well versed with the different terminologies used in the gem industry and to provide skills to become a successful gemmologist.

(ii) Broad contents of the course:

The course covers the various aspects of gem testing using both theoretical as well as lab work by dealing with basics to the advanced techniques of gemstone identification. Further, it deals with the methods employed by diamond industry in cutting a rough diamond into a sparkling gem and how diamonds are graded internationally. Why synthetic gemstones have flooded the market and how they are manufactured is then next topic, including their detection.

(iii) Skills to be learned

The students will acquire skills which will be useful to them in the gem industry.

(iv)The detail contents of this course and references and suggested books

Gemmology: Introduction to Gems, basic properties of gems, Formation of gem stones (4), Use of refractometers, Polariscope, Dichroscope(4), Methods of Specific Gravity determination (2),Causes of colours in gemstones (1), Introduction to special optical properties like chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc.(5), Distinction between synthetic and natural gem stones (3).

Use of Gem Testing Instruments: hand lens (10x), Detection of double refraction, by observing pleochroic colours with the Dichroscope (4), Identification of gemstones on the basis of pleochroic colours; Detection of double refraction, interference figures and internal strain with the Polariscope (2), study of the fluorescent colours exhibited by various gemstones under Ultraviolet (long wave and short wave) light (3), Measurement of refractive indices and birefringence tests using a gem-testing Refractometer (2),

Books Recommended:

Karanth R.V (2000) Gems and Gem Industry in India, Geological society of India.
Read, P. G.(1991) Gemmology, Butterworth-Heinemann Ltd.
Webster, R. and edited by Anderson, B.W. (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd.
Sinkankas, J. (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.
Karanth R.V (2008) Gemstones Enchanting Gifts of Nature, Geological society of India.
Fareeduddin & R. H. Mitchell (2012) Diamonds and their Source rocks in India, Geological society of India.
Babu T.M (1998) Diamonds in India, Geological Society of India.

GL-SEC-21602: MEDICAL GEOLOGY

(2 Credits)

(i) Course learning outcome:

On completion of the course the student will be able to understand the distribution of trace elements and its cyclic movement through the abiotic-biotic environment and their influence on human health, flora and fauna.

(ii) Broad contents of the course:

The course is designed to include the basic concepts of Medical Geology, interaction between abundances of elements and isotopes and the health of humans and plants

(iii) Skills to be learned:

The course provides a basic understanding or geogenic and anthropogenic distribution of trace elements, their toxic effects on human health and that of flora and fauna.

(iv)The detail contents of this course and references and suggested books

This course introduces students to the basic concepts of Medical Geology (2), interaction between abundances of elements and isotopes and the health of humans and plants (2). The public health effects of Earth materials and geological processes(2), medical impacts of water quality, biogeochemical interactions and nutrient anomalies, anthropogenic degradation of geological environments, application of geochemistry to environmental health issues(8), geospatial analysis as a tool in epidemiology(3), health hazards associated with volcanic eruptions(2), global dust flux and respiratory problems(2), impacts of radon-arsenic-selenium-mercury-iodine, uranium on physiological function(8), carcinogenic associations with coal and fibrous minerals (42), geological effects on animal health, and geophagy (human ingestion of soil materials as a dietary supplement) (3).

Books Recommended:

Eisenbud, M. and T. Gesell. (1997) Environmental radioactivity from natural, industrial, and military sources, Academic Press.

Dissanayake, C. B. and Chandrajith, R. (2009) Introduction to Medical Geology, Springer-Verlag Berlin Heidelberg.

Miomir Komatina (2004) Medical Geology, Volume 2, Effects of Geological Environments on Human Health, Elsevier Science.

GL-SEC-21603: OIL FIELD SERVICES

(2 Credits)

(i) Course learning outcome:

This course is to be taken in combination with Petroleum geology. The course focuses on the mud logging component as a supplementary service industry in oil and natural; gas exploration.

(ii) Broad contents of the course:

The course deals with Oil Well Drilling, logging and monitoring. It also deals with techniques for formation evaluation and testing for oil and gas.

(iii) Skills to be learned:

The students who completes this course will have acquired all the skills needed for mud logging job and can be employed with private and public organisations engaged in oil exploration.

(iv)The detail contents of this course and references and suggested books

Introduction to Oil Well Drilling, Types oil wells and geotechnical order (2), Methods of Oil well drilling: Cable tool drilling and rotary drilling (2), Components of rotary drilling system(2), Monitoring of drilling process i.e. depth ROP, WOB, sampling (2), Concept of Subsurface pressure(2), Types of Drilling Rigs: Onshore and offshore rigs,(3) Controlled Directional Rotary Drilling, Horizontal Drilling(2), Drilling Mud: Mud hydraulics, uses and functions of drilling mud (2). Coring-Introduction, Techniques and Applications of Coring in Petroleum Geology (2).

Formation Evaluation: Wire line logs, Basic Principles (2), tools of SP, gamma ray, Neutron, Density, Caliper, Dipmeter, Temperature and Sonic Logs and their interpretation(3). Mud logging: Principle, techniques and tools of mud logging(2).Interpretation of gas, drilling and mud parameters.MWD (Measurement While Drilling)/LWD (Logging While Drilling) (2). Principle and tools of MWD/LWD, data analysis and interpretation (2), Formation (Drillstem) Testing: Introduction, Tools and Techniques of DST (2).

Books Recommended:

Sahay, B., Rai, A. and Ghosh, M. Wellsite (1997) Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi.

Selley, R.C. (1984) Elements of Petroleum Geology, Academic Press, London.