

# **Kazi Nazrul University**

## **Syllabus for B.Sc. (Hons.) in Geology**

**Six Semester Course Under  
Choice Based Credit System**

YEAR	SEMESTER	CORE COURSE (14)	ABILITY ENHANCEMENT COURSE (2)	SKILL ENHANCEMENT COURSE (3)	DISCIPLINE SPECIFIC ELECTIVE (DSE) (4)	GENERIC ELECTIVE (GE) (4)
FIRST YEAR	I	1. EARTH SYSTEM SCIENCE 2. MINERAL SCIENCE	COMMUNICATIVE ENGLISH			GE-1
	II	3. ELEMENTS OF GEOCHEMISTRY 4. STRUCTURAL GEOLOGY	ENVIRONMENTAL SCIENCE			GE-2
SECOND YEAR	III	5. IGNEOUS PETROLOGY 6. SEDIMENTOLOGY 7. PALEONTOLOGY		SEC-I (Field Work)		GE-3
	IV	8. METAMORPHIC PETROLOGY 9. STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY 10. HYDROGEOLOGY		SEC-II (Field Work)		GE-4
THIRD YEAR	V	11. ECONOMIC GEOLOGY 12. FUEL GEOLOGY			DSE - 1 DSE - 2	
	VI	13. ENGINEERING GEOLOGY 14. REMOTE SENSING AND GIS			DSE - 3 DSE - 4	

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
I	Ability Enhancement: compulsory course - I	Communicative English	2
	Core Course - I	Earth System Science	4
		Practical	2
	Core Course - II	Mineral Science	4
		Practical	2
	Generic Elective - I	GE - I	6
<b>Total Credit</b>			<b>20</b>
SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
II	Ability Enhancement: compulsory course - II	Environmental Science	2
	Core Course - III	Elements of Geochemistry	4
		Practical	2
	Core Course - IV	Structural Geology	4
		Practical	2
	Generic Elective - II	GE - II	6
<b>Total Credit</b>			<b>20</b>
SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
III	Core Course - V	Igneous Petrology	4
		Practical	2
	Core Course - VI	Sedimentology	4
		Practical	2
	Core Course - VII	Paleontology	4
		Practical	2
	Generic Elective - III	GE - III	6
Skill Enhancement Course - I	Field Work	2	
<b>Total Credit</b>			<b>26</b>
SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
IV	Core Course - VIII	Metamorphic Petrology	4
		Practical	2
	Core Course - IX	Stratigraphic Principles and Indian Stratigraphy	4
		Practical	2
	Core Course - X	Hydrogeology	4
		Practical	2
	Generic Elective - IV	GE - IV	6
Skill Enhancement Course - II	Field Work	2	
<b>Total Credit</b>			<b>26</b>

<b>SEMESTER</b>	<b>COURSE OPTED</b>	<b>COURSE NAME</b>	<b>CREDIT</b>
<b>V</b>	Core Course - XI	Economic Geology	4
		Practical	2
	Core Course - XII	Fuel Geology	4
		Practical	2
	Discipline Specific Elective - I	DSE - I	4
		Practical	2
	Discipline Specific Elective - II	DSE - II	4
		Practical	2
<b>Total Credit</b>			<b>24</b>
<b>SEMESTER</b>			
<b>SEMESTER</b>	<b>COURSE OPTED</b>	<b>COURSE NAME</b>	<b>CREDIT</b>
<b>VI</b>	Core Course - XIII	Engineering Geology	4
		Practical	2
	Core Course - XIV	Remote Sensing & GIS	4
		Practical	2
	Discipline Specific Elective - III	DSE - III	4
		Practical	2
	Discipline Specific Elective - IV	DSE - IV	4
		Practical	2
<b>Total Credit</b>			<b>24</b>
<b>Grand Total of Credits in Six Semesters</b>			<b>140</b>

**CORE COURSE: GEOLOGY**  
**Paper -I**  
**EARTH SYSTEM SCIENCE**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

**Unit 1: Earth System Science**

Definition and scope; General characteristics and origin of the Universe, Solar System and its planets; the terrestrial and jovian planets.

Meteorites and Asteroids

Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age.

**Unit 2: Solid Earth and its fluid cover**

Internal constitution - its recognition vis-à-vis solid earth geophysics: crust, mantle, core, evidence from seismic waves and rocks

Hydrosphere, atmosphere and biosphere: Elementary idea

Nature of Earth's magnetic field

**Unit 3: Plate Tectonics**

Concept of continental drift vis-a-vis plate tectonics, sea-floor spreading

Plate boundaries: Mid Oceanic Ridges, trenches, transform faults and island arcs

Concept of isostasy, isostatic condition of India

Internal process and its superficial manifestation – volcanoes and volcanism, distribution of volcanoes: causes of earthquakes and their effects, intensity and magnitude, earthquake belts, seismic zones of India.

**Unit 4: Hydrosphere and Atmosphere**

Oceanic current system and effect of Coriolis force

Concepts of eustasy

Land-sea interaction along coast

Weather and climatic changes

**Unit 5: Earth surface processes**

Weathering; erosion; mass wasting; Geological work of wind, river and glacier

Formation of soil, soil profile and soil types

**Unit 6: Introduction to the concept of time in geological studies**

Stratigraphy: definition and scope

Brief history of development of stratigraphic principles; concepts of Neptunism, Plutonism and Uniformitarianism

Geological Time Table, introduction to geochronological methods and their application in geological studies

Fundamental laws of stratigraphy: Superposition, Faunal succession and correlation

### **Unit 7: Cosmic abundance of elements**

Distribution of elements in solar system and in Earth

Introduction to chemical differentiation and composition of the Earth

General concepts about geochemical cycles

### **PRACTICALS**

Study of major geomorphic features and their relationships with outcrops through physiographic models and maps

Detailed study of topographic sheets and preparation of physiographic description of an area

Study of distribution of cratons, mobile belts and major sedimentary basins on the map of India

### **SUGGESTED READINGS:**

1. Duff, P. M. D., & Duff, D (Eds.) (1993) *Holmes' principles of physical geology*. Taylor & Francis.

2. Emiliani, C. (1992) *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.

3. Gross, M. G. (1977) *Oceanography: A view of the earth*.

## **CORE COURSE: GEOLOGY**

### **Paper -II**

#### **MINERAL SCIENCE**

(CREDITS: THEORY-4, PRACTICALS-2)

### **THEORY LECTURES**

#### **Unit 1: Crystallography**

Elementary ideas about crystal morphology in relation to internal structures

Crystal parameters and indices

Crystal symmetry and classification of crystals into point groups, space groups and crystal systems

#### **Unit 2: Crystal projection**

Stereographic projections of symmetry elements and forms

#### **Unit 3: Rock forming minerals**

Minerals - definition and classification, physical and chemical properties

Substitution principles - Goldschmidt's rule of substitution of elements; partitioning of elements between coexisting phases; Brief idea about Isomorphism, Solid solution, Pseudomorphism and

Polymorphism: elementary concept on principle types - common polymorphic forms of C, SiO<sub>2</sub> and Al<sub>2</sub>SiO<sub>5</sub>

Crystal structure and its controls: bonding and coordination principles.

Classification of silicate groups based on structure and derivation of structural formulae based on composition

Non-silicate structures; CCP and HCP structures

#### **Unit 4: Optical mineralogy**

Optical behaviour of crystals – Isotropic and anisotropic minerals; Nicol prism and its principle of construction; Polaroid; Refractive index of minerals; Uniaxial & Biaxial minerals; Optical indicatrix of uniaxial and biaxial minerals; Birefringence, Interference colour and use of interference colour chart; Relation between crystallographic and optical axes of crystals  
Pleochroism and pleochroic scheme; Extinction; Study of interference figures; Optic sign of uniaxial and biaxial minerals

#### **PRACTICALS**

Study of the symmetry of crystals

Study of physical properties of minerals in hand specimen: Olivine, Garnet, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Pyroxene, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Quartz, Alkali feldspar, Plagioclase, Nepheline, Sodalite, Zeolite  
Pyrite, Chalcopyrite, Galena, Sphalerite, Graphite, Magnetite, Haematite, Fluorite, Calcite, Dolomite, Gypsum, Asbestos, Ilmenite, Chromite, Pyrolusite, Psilomelane, Bauxite

Study of optical properties of common rock-forming minerals: quartz, orthoclase, microcline, plagioclase, perthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, staurolite, garnet, muscovite, biotite, calcite

#### **SUGGESTED READINGS:**

1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.

### **CORE COURSE: GEOLOGY**

#### **Paper -III**

#### **ELEMENTS OF GEOCHEMISTRY**

(CREDITS: THEORY-4, PRACTICALS-2)

#### **THEORY LECTURES**

##### **Unit 1: Concepts of geochemistry**

Introduction to properties of elements: The periodic table  
Chemical bonding, states of matter and atomic environment of elements  
Geochemical classification of elements

##### **Unit 2: Layered structure of Earth and geochemistry**

Composition of different Earth reservoirs and the nuclides and radioactivity  
Concept of radiogenic isotopes in geochronology and isotopic tracers

##### **Unit 3: Element transport**

Advection and diffusion  
Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations

#### **Unit 4: Geochemistry of solid Earth**

The solid Earth – geochemical variability of magma and its products  
Composition of the bulk silicate Earth  
Meteorites

#### **Unit 5: Geochemical behavior of selected elements**

Si, Al, K, Na, Ca, Fe, Mg, Ti.

#### **Unit 6: Brief introduction to analytical instruments and geochemical data**

EPMA, XRF, ICPMS

### **PRACTICALS**

Interpretation of geochemical data: Bivariate and trivariate plots to delineate the control of different compositional variables: Harker variation diagram, AFM diagram, MgO diagram, compatible and incompatible element variation.

#### **SUGGESTED READINGS:**

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

### **CORE COURSE: GEOLOGY**

#### **Paper -IV**

#### **STRUCTURAL GEOLOGY**

(CREDITS: THEORY-4, PRACTICALS-2)

### **THEORY LECTURES**

#### **Unit 1: Basic structural elements**

Introduction to structural geology; Diastrophic and non- diastrophic structures; Components of structural elements: planar and linear features, concept of dip and strike, trend and plunge, rake/pitch; Application of primary sedimentary and igneous structure in structural geology for determining younging direction; Unconformity and its types.

#### **Unit 2: Rock deformation**

Concept of rock deformation: Stress and Strain in rocks, Strain ellipse and ellipsoids of different types and their geological significance.

#### **Unit 3: Folds**

Fold morphology; Geometric classification, mechanics of folding: Buckling, Bending, Flexural slip and flow folding; genetic classification of folds



#### **Unit 4: Foliation and lineation**

Types of foliations and lineations, their tectonic significance and relationship with other structures

#### **Unit 5: Fractures and faults**

Classification of fractures and faults and their relationship with strain

Effects of faulting on the outcrops

Geologic/geomorphic criteria for recognition of faults and determination of net slip

### **PRACTICALS**

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:**

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

### **CORE COURSE: GEOLOGY**

#### **Paper -V**

#### **IGNEOUS PETROLOGY**

(CREDITS: THEORY-4, PRACTICALS-2)

#### **THEORY LECTURES**

##### **Unit 1: Introduction to Igneous petrology**

Principal modes of magma formation in the crust and upper mantle; physical properties of magma - temperature, viscosity, density and volatile content; formation and types of igneous rocks: volcanic, hypabyssal, plutonic.

##### **Unit 2: Form and structure**

Description of different forms and structures of igneous bodies with emphasis on their mode of emplacement - sill, dyke, ring dyke, cone sheet, laccolith, lopolith, phaccolith, batholith, pillow structure, ropy and aa lava structure, columnar joints etc.

##### **Unit 3: Textures and microstructures**

Crystallinity, granularity, shapes and mutual relations of grains; nucleation and growth of igneous minerals

Description of the following textures and microstructures with their occurrence in different rocks - panidiomorphic, hypidiomorphic, allotriomorphic, porphyritic, vitrophyric, poikilitic, ophitic, sub-ophitic, intergranular, intersertal, pilotaxitic, trachytic, graphic, granophyric, rapakivi, orbicular, corona, perthitic, myrmekitic, variolitic, speherulitic & spinifex.

#### **Unit 4: Classification of igneous rocks**

Bases of classification of igneous rocks: mineralogical, textural, chemical, chemico-mineralogical and associational; Norm and mode; Standard classification schemes - Niggli, Hatch, Wells & Wells and IUGS

#### **Unit 5: Phase diagrams**

Elementary idea of Phase Rule and its application to eutectic, peritectic and solid solution system: Phase equilibria in the following binary and ternary systems, and their petrogenetic significance: diopside - anorthite, forsterite - silica, albite - anorthite, albite - orthoclase, diopside - albite - anorthite, forsterite - diopside - silica and nepheline - kalsilite - silica.

#### **Unit 6: Petrography of the common igneous rock types**

Granitoids, Pegmatite, Syenite, Monzonite, Diorite, Norite, Gabbro, Anthrothosite, Dolerite, Pyroxenites, Peridotite, Lamprophyres, Carbonatite, Rhyolite, Andesite, Dacite, Basalt, Komatiite.

#### **Unit 5: Petrogenesis of igneous rocks**

Crystallization - Differentiation of a magma, brief idea on several mechanisms of magmatic differentiation, Bowen's reaction series and its implications; Elementary knowledge of petrogenesis of the following rocks: granite, basalt and ultramafic rocks.

### **PRACTICALS**

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, syenite, nepheline syenite, gabbro, anorthosites, ultramafic rocks, basalts, andesites. Hands on problems related to following variation diagrams: Total alkali-silica diagram, Harker variation diagram,  $\text{FeO}^T - \text{MgO} - (\text{Na}_2\text{O} + \text{K}_2\text{O})$  diagram; their implications to draw petrogenetic conclusions.

#### **SUGGESTED READINGS:**

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

8. Bose M.K. (1997). Igneous Petrology.
9. G W Tyrrell. (1926). Principles of Petrology. Springer

**CORE COURSE: GEOLOGY**  
**Paper -VI**  
**SEDIMENTOLOGY**  
(CREDITS: THEORY-4, PRACTICALS-2)

**THEORY LECTURES**

**Unit 1: Introduction to Sedimentology**

Outline of sedimentation process: Definition of sediment; origin of sediments: mechanical and chemical sediments; source rock or provenance.

**Unit 2: Granulometry**

Grain size: concept and size scale, particle size distribution, environmental connotation; particle shape and fabric; Sedimentary textures

**Unit 3: Basic hydraulics and Sedimentary structures**

Fluid flow: Types of fluids, Laminar and turbulent flow, subcritical, critical and supercritical flows; concept of mean flow velocity, unit discharge and bed shear stress; flow profile and flow separation; particle entrainment, transport and deposition

Mass flow: types, mechanisms and controlling factors, process-product relationship

Penecontemporaneous deformation: mechanisms and controlling factors

Sedimentary structure: Primary and penecontemporaneous deformation structures

Bedform stability diagram

Paleocurrent analysis: Data acquisition, methodology, different paleocurrent patterns.

**Unit 4: Sedimentary rocks**

Siliciclastic rocks: Components and classification(s) of conglomerates and sandstones

Tectonic control on sandstone composition

General introduction to mudrocks

Carbonate rocks, controlling factors of carbonate deposition, components and classifications of limestone; dolomite and dolomitisation

**Unit 5: Diagenesis**

Concepts of diagenesis

Stages of diagenesis; diagenetic changes in sand and carbonate deposits, lithification.

**PRACTICALS**

Exercises on sedimentary structures

Particle size distribution and statistical analysis

Paleocurrent analysis

Petrographic study of clastic and non-clastic rocks in hand specimens and thin sections

**SUGGESTED READINGS:**

1. Allen, J.R.L., 1985. *Principles of Physical Sedimentology*. George Allen and Unwin, London
2. Prothero, D. R., & Schwab, F. (2004). *Sedimentary geology*. Macmillan.
3. Tucker, M. E. (2006) *Sedimentary Petrology*, Blackwell Publishing.
4. Collinson, J. D. & Thompson, D. B. (1988) *Sedimentary structures*, Unwin- Hyman, London.
5. Nichols, G. (2009) *Sedimentology and Stratigraphy*, Second Edition. Wiley Blackwell

**CORE COURSE: GEOLOGY**  
**Paper -VII**  
**PALEONTOLOGY**  
(CREDITS: THEORY-4, PRACTICALS-2)

**THEORY LECTURES**

**Unit I: Fossilization and fossil records**

Processes relating to fossilization of invertebrates, vertebrates, plants and trace fossils; taphonomy, modes of preservation; Importance of fossil records – fossil lagerstätten.

**Unit II: Taxonomy and species concept**

Species concept with special reference to palaeontology, Taxonomic hierarchy, Procedures for formal description and nomenclature of species. Theory of organic evolution: speciation, microevolution, macroevolution, examples from fossil records.

**Unit III: Invertebrates**

Study of morphological features as preserved in fossils of important invertebrate groups: Bivalvia, Gastropoda, Cephalopoda, Brachiopoda, Echinodermata and their functional aspects.

**Unit IV: Vertebrates**

Origin of vertebrates and major steps in vertebrate evolution: origin of jaws, amniotic eggs, diversification of terrestrial habitat, Mesozoic reptiles with special reference to origin, diversity and extinction of dinosaurs; Major traits in horse evolution and intercontinental migrations; major traits in hominid evolution and records of hominid fossils in Indian subcontinent.

**Unit V: Palaeobotany**

Study of plant morphology found to be preserved as fossils, Gondwana flora.

**Unit VI: Microfossils**

General overview of microfossils; Study of foraminifera: morphology of living and fossil forms; dimorphic and trimorphic variations; wall structure and composition of foraminiferal tests.

**Unit VII: Application of palaeontology**

Biostratigraphy: biozone, index fossil, correlation. Significance of ammonite in Mesozoic Biostratigraphy

Palaeobiogeography: biogeographic provinces, dispersal and barriers

Palaeoecology: Interpretation of palaeoecological aspects from fossil record

### **PRACTICALS**

Study of fossils showing various modes of preservation

Study of diagnostic morphological characters up to family level of Bivalvia, Gastropoda, Cephalopoda, Brachiopoda and Echinodermata

Study of the functional aspects of morphological features of Bivalvia

Study of diagnostic morphological characters, generic identification and stratigraphic position of plant fossils

### **SUGGESTED READINGS**

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
5. Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

## **CORE COURSE: GEOLOGY**

### **Paper -VIII**

#### **METAMORPHIC PETROLOGY**

(CREDITS: THEORY-4, PRACTICALS-2)

### **THEORY LECTURES**

#### **Unit 1: Metamorphism - controls and types**

Definition of metamorphism; factors controlling metamorphism; types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism.

#### **Unit 2: Quantification of equilibrium in metamorphism**

Metamorphic rocks as geochemical systems; Application of chemical thermodynamics in homogeneous phase equilibria; Geothermobarometry

#### **Unit 3: Metamorphic facies and grades**

Concept of equilibrium; Index minerals; composition paragenesis diagram (ACF, AKF, AFM projection); metamorphic zones and isogrades.

Concept of metamorphic facies and grade; mineralogical phase rule of closed and open system

#### **Unit 4: Metamorphism and Tectonism**

Relationship between metamorphism and deformation; structure and textures of metamorphic rocks metamorphic mineral reactions (prograde and retrograde); Metamorphic Facies Series; Paired Metamorphic Belt.

### **Unit 5: Types of metamorphism**

Progressive metamorphism of pelitic and basic rocks; Contact metamorphism of impure limestone; Crustal anatexis, Partial melting in metamorphic rocks; Migmatites and their origin; Metasomatism and role of fluids in metamorphism.

### **Unit 5: Metamorphic rock associations**

Schists, gneisses, khondalites, charnockites, blue schists and eclogites.

## **PRACTICALS**

Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks:  
Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite-quartz schist, slate, talc-tremolite-calcite-quartz schist.

Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble.

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

### **SUGGESTED READINGS:**

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

## **CORE COURSE: GEOLOGY**

### **Paper -IX**

#### **STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY (CREDITS: THEORY-4, PRACTICALS-2)**

### **THEORY LECTURES**

#### **Unit 1: Principles of stratigraphy**

Stratigraphic units; Definition of lithostratigraphic, biostratigraphic and chronostratigraphic units  
Introduction to concepts of dynamic stratigraphy: chemostratigraphy, seismic stratigraphy, sequence stratigraphy, Magnetostratigraphy

#### **Unit 2: Stratigraphic Principles**

International Stratigraphic Code – development of a standardized stratigraphic nomenclature.  
Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).

### **Unit 3: Stratigraphic analysis**

Principles of stratigraphic correlation

Facies concept in stratigraphy; Walther's Law of Facies.

Basic concept of paleogeographic reconstruction

### **Unit 4: Physiographic and tectonic subdivisions of India**

Brief introduction to the physiographic and tectonic subdivisions of India.

Introduction to Indian Shield: Geology of the Precambrian cratons: Dharwar, Singbhum, Aravalli, Bastar.

Introduction to Proterozoic basins of India: Geology of Vindhyan and Cudappah basins of India

### **Unit 5: Phanerozoic Stratigraphy of India**

Paleozoic Succession of Kashmir and its correlatives from Spiti and Zaskar Stratigraphy

Stratigraphy of Gondwana basins.

Mesozoic stratigraphy of India:

a. Triassic successions of Spiti,

b. Jurassic of Kutch,

c. Cretaceous successions of Cauvery basins

Cenozoic stratigraphy of India:

a. Kutch basin,

b. Siwalik successions,

c. Assam, Andaman and Arakan basins.

Unit 6: Volcanic provinces of India

a. Deccan,

b. Rajmahal,

c. Sylhet Trap

Unit 7: Stratigraphic boundaries

Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary

## **PRACTICALS**

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

### **SUGGESTED READINGS:**

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

**CORE COURSE: GEOLOGY**  
**Paper -X**  
**HYDROGEOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

**Unit 1: Introduction and basic concepts**

Scope of hydrogeology and its societal relevance

Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water.

Rock properties affecting groundwater, Vertical distribution of subsurface water

Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers

**Unit 2: Groundwater flow**

Darcy's law and its validity

Intrinsic permeability and hydraulic conductivity

Groundwater flow rates and flow direction

Laminar and turbulent groundwater flow

**Unit 3: Well hydraulics and Groundwater exploration**

Basic Concepts (drawdown; specific capacity etc.)

Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers.

Surface-based groundwater exploration methods

Introduction to subsurface borehole logging methods

**Unit 4: Groundwater chemistry**

Physical and chemical properties of water and water quality

Introduction to methods of interpreting groundwater quality data using standard graphical plots

Sea water intrusion in coastal aquifers

**Unit 5: Groundwater management**

Surface and subsurface water interaction

Groundwater level fluctuations

Basic concepts of water balance studies, issues related to groundwater resources development and management

Rainwater harvesting and artificial recharge of groundwater

Brief idea about groundwater pollution and its mitigation

**PRACTICALS**

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)

Determination of hydraulic gradient/slope from water table depth data.

Simple numerical problems related to: determination of permeability in field and laboratory



### **SUGGESTED READINGS:**

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

**CORE COURSE: GEOLOGY**  
**Paper -XI**  
**ECONOMIC GEOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

#### **Unit 1: Ores and gangues**

Ores, gangue minerals, tenor, grade and lodes  
Resources and reserves- Economic and Academic definitions

#### **Unit 2: Mineral deposits and classical concepts of Ore formation**

Mineral occurrence, Mineral deposit and Ore deposit  
Historical concepts of ore genesis: Man's earliest vocation- Mining  
Plutonist and Neptunist concepts of ore genesis

#### **Unit 3: Mineral exploration**

Exploration and exploitation techniques  
Brief outline of Remote Sensing, Geophysical and Geochemical Explorations  
Geological mapping at different scales, drilling, borehole logs and transverse sections

#### **Unit 4: Structure and texture of ore deposits**

Concordant and discordant ore bodies  
Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits  
Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits,

#### **Unit 5: Grade and Reserve**

Assessment of grade of ore; reserve estimation

#### **Unit 6: Metallic and Nonmetallic ores**

Metallogenic provinces and epochs  
Important deposits of India including atomic minerals  
Non-metallic and industrial rocks and minerals, in India  
Introduction to gemstones.

## PRACTICALS

Megascope identification

Study of microscopic properties of ore forming minerals (Oxides and sulphides).

Preparation of maps showing distribution of important ores and other economic minerals in India.

### SUGGESTED READINGS:

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2012) Crustal Evolution and Metallogeny in India. Cambridge Publications.

## CORE COURSE: GEOLOGY

### Paper -XII

#### FUEL GEOLOGY

(CREDITS: THEORY-4, PRACTICALS-2)

### THEORY LECTURES

#### Unit 1: Coal

Definition and origin of Coal

Basic classification of coal

Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal

Proximate and Ultimate analysis, chemical properties of coal

#### Unit 2: Coal Bed Methane

Coal Bed Methane (CBM): global and Indian scenario

Underground coal gasification

Coal liquefaction

#### Unit 3: Petroleum

Chemical composition and physical properties of crudes in nature

Origin of petroleum: favourable geological conditions, source material, maturation of organic matter -

Biogenic and Thermal effect; Kerogen: types and relation to the origin of petroleum hydrocarbons

#### Unit 4: Petroleum system

Source rock, reservoirs and cap rock

Source rock: general attributes

Reservoir rocks: general attributes and petrophysical properties

Cap rocks: definition and general properties.

Migration of petroleum hydrocarbons

Hydrocarbon traps: definition, anticlinal theory and trap theory  
Classification of hydrocarbon traps - structural, stratigraphic and combination  
Time of trap formation and time of hydrocarbon accumulation.  
Plate tectonics and global distribution of hydrocarbon reserves  
Petroliferous basins of India

**Unit 5: Other fuels**

Gas Hydrate  
Nuclear Fuel

**PRACTICALS**

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

**SUGGESTED READINGS:**

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

**CORE COURSE: GEOLOGY**  
**Paper -XIII**  
**ENGINEERING GEOLOGY**  
(CREDITS: THEORY-4, PRACTICALS-2)

**THEORY LECTURES**

**Unit 1: Introduction**

Role of Engineering geologists in planning, design and construction of major man-made structural features

**Unit 2: Site investigation and characterization**

**Unit 3: Foundation treatment**

Grouting, Rock Bolting and other support mechanisms

**Unit 4: Intact Rock and Rock Mass properties**

Rock aggregates; Significance as Construction Material

**Unit 5: Rock Quality Designation (RQD)**

Concept, Mechanism and Significance of:

- a. Rock Structure Rating (RSR)

- b. Rock Mass Rating (RMR)
- c. Tunneling Quality Index (Q)

Geological, Geotechnical and Environmental considerations for Dams and Reservoirs

**Unit 6: Tunnel**

Tunneling Methods

**Unit 7: Landslides**

Causes, Factors and corrective/preventive measures

**Unit 8: Earthquakes**

Causes, Factors and corrective/preventive measures

**Unit 9: Case histories related to Indian Civil Engineering Projects**

**PRACTICALS**

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:**

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

**CORE COURSE: GEOLOGY**  
**Paper -XIV**  
**REMOTE SENSING AND GIS**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

**Unit 1: Photogeology**

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 and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms

## **Unit 2: Remote Sensing**

Concepts in Remote Sensing

Sensors and scanners

Satellites and their characteristics

Data formats- Raster and Vector

## **Unit 3: Digital Image Processing**

Image Errors, Rectification and Restoration, FCC, Image Enhancement, Filtering, Image Rationing, Image classification and accuracy assessment

GIS integration and Case studies-Indian Examples

## **Unit 4: GIS**

Datum, Coordinate systems and Projection systems

Spatial data models and data editing

Introduction to DEM analysis

## **Unit 5: GPS**

Concepts of GPS

Integrating GPS data with GIS

Applications in earth system sciences

## **PRACTICALS**

Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms

Introduction to DIP and GIS softwares. Digital Image Processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures, 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 Classification of images; DEM analysis: generating slope map, aspect map and drainage network map and its applications

## **SUGGESTED READINGS:**

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

**DISCIPLINE SPECIFIC ELECTIVE**  
**Paper - I**  
**EXPLORATION GEOLOGY**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

**Unit 1: Mineral Resources**

Resource reserve definitions, Mineral resources in industries – historical perspective and present; brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies

**Unit 2: Prospecting and Exploration**

Principles of mineral exploration; Prospecting and exploration- conceptualization, methodology and stages; Sampling, subsurface sampling including pitting, trenching and drilling; Geochemical exploration

**Unit 3: Evaluation of data**

Evaluation of sampling data  
Mean, mode, median, standard deviation and variance

**Unit 4: Drilling and Logging**

Core and non-core drilling  
Planning of bore holes and location of boreholes on ground  
Core-logging

**Unit 5: Reserve estimation**

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)  
Regular and irregular grid patterns, statistics and error estimation

**PRACTICALS**

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

**SUGGESTED READINGS:**

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

**DISCIPLINE SPECIFIC ELECTIVE**  
**Paper -II**  
**EARTH AND CLIMATE**  
**(CREDITS: THEORY-4, PRACTICALS-2)**

**THEORY LECTURES**

**Unit 1: Climate system**

Forcing and Responses

Components of the climate system

Climate forcing, Climate controlling factors

Climate system response, response rates and interactions within the climate system

Feedbacks in climate system

**Unit 2: Heat budget of Earth**

Incoming solar radiation, receipt and storage of heat

Heat transformation

Earth's heat budget. Interactions amongst various sources of earth's heat

**Unit 3: Atmosphere - Hydrosphere**

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

Surface and deep circulation

Sea ice and glacial ice

**Unit 4: Response of biosphere to Earth's climate**

Climate Change: natural vs. anthropogenic effects

Humans and climate change

Future perspectives

Brief introduction to archives of climate change

Archive based climate change data from the Indian continent

**Unit 5: Orbital cyclicity and climate**

Milankovitch cycles and variability in the climate

Glacial-interglacial stages

The Last Glacial maximum (LGM)

Pleistocene Glacial-Interglacial cycles

Younger Dryas

Marine isotope stages

**Unit 6: Monsoon**

Mechanism of monsoon

Monsoonal variation through time

Factors associated with monsoonal intensity

Effects of monsoon

## PRACTICALS

Study of distribution of major climatic regimes of India on map

Distribution of major wind patterns on World map

Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals

Numerical exercises on interpretation of proxy records for paleoclimate

### SUGGESTED READINGS:

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

## DISCIPLINE SPECIFIC ELECTIVE

### Paper -III

### GEOMORPHOLOGY

(CREDITS: THEORY-4, PRACTICALS-2)

### THEORY LECTURES

#### **Unit 1: Introduction to Geomorphology**

Endogenic and Exogenic processes

#### **Unit 2: Major Morphological features**

Geoid, Topography, Hypsometry, Global Hypsometry, Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya).

#### **Unit 3: Surficial Processes and geomorphology**

Weathering and associated landforms, Hill slopes

Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities

#### **Unit 4: Endogenic- Exogenic interactions**

Rates of uplift and denudation, Tectonics and drainage

development, Sea-level change, Long-term landscape development

#### **Unit 5: Overview of Indian Geomorphology, Extraterrestrial landforms**



## PRACTICALS

Reading topographic maps, Concept of scale, 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:

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons

## DISCIPLINE SPECIFIC ELECTIVE

### Paper -IV

#### RIVER SCIENCE

(CREDITS: THEORY-4, PRACTICALS-2)

### THEORY LECTURES

#### Unit 1: Stream hydrology

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: River basin

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

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: Rivers in time and space

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: Channels and Landscapes**

Bedrock channels, Bedrock incision process  
River response to climate, tectonics and human disturbance  
Bedrock channel processes and evolution of fluvial landscapes.

### **Unit 6: Fluvial hazards**

Integrated approach to stream management  
Introduction to river ecology

## **PRACTICALS**

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

### **SUGGESTED READINGS:**

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

## **DISCIPLINE SPECIFIC ELECTIVE**

### **Paper -V**

**EVOLUTION OF LIFE THROUGH TIME**  
(CREDITS: THEORY-4, PRACTICALS-2)

## **THEORY LECTURES**

### **Unit 1: Life through ages**

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

### **Unit 2: Geobiology**

Biosphere as a system, processes and products  
Biogeochemical cycles  
Abundance and diversity of microbes, extremophiles  
Microbes-mineral interactions, microbial mats

### **Unit 3: Origin of life**

Possible life sustaining sites in the solar system, life sustaining elements and isotope records  
Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life

Precambrian macrofossils – The garden of Ediacara  
The Snow Ball Earth Hypothesis

### **Unit 4: Paleozoic Life**

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

### **Unit 5: Mesozoic Life**

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

### **Unit 6: Cenozoic Life**

Aftermath of end Cretaceous mass extinction – radiation of placental mammals  
Evolution of modern grasslands and co-evolution of hoofed grazers  
Rise of modern plants and vegetation  
Back to water – Evolution of Whales

### **Unit 7: The age of humans**

Hominid dispersals and climate setting  
Climate Change during the Phanerozoic - continental break-ups and collisions  
Plate tectonics and its effects on climate and life  
Effects of life on climate and geology

## **PRACTICALS**

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants

### **SUGGESTED READINGS:**

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

**DISCIPLINE SPECIFIC ELECTIVE**  
**Paper -VI**  
**URBAN GEOLOGY**  
(CREDITS: THEORY-4, PRACTICALS-2)

**THEORY LECTURES**

**Unit 1: Geology and Society**

Necessity of Geology in Urban life.

Geology in Urban Constructions

Geotechnical feature and mapping for subsurface in Metropolitan areas

Building materials, Excavation and cutting in urban areas.

**Unit 2: Geology and Urban Agriculture**

Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer

Effect of pollutants on vegetable contamination

**Unit 3: Urban land use**

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

Urban Tunneling: Tunneling for road and rail in urban areas, Method, Equipments, Importance of Geology

**Unit 4: Urban water**

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, Ground water surveys and resource development.

**Unit 5: Urban wastes and Treatment**

Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Mine drainage, Power production waste, Radioactive waste, Need for special purpose mapping for selection of waste disposal sites.

**Unit 6: GIS in Urban Geology**

GIS-An introduction, Application in Urban development, Application in landuse, Application in GW Exploration.

**Unit 7: Precaution from seismic hazard in Urban planning**

Seismic Hazards: Micro-zonations of hazard based on engineering geological features, Urbansubservice network.

## PRACTICALS

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

### SUGGESTED READINGS:

1. Huggenberger, P. and Eptin, J. 2011 Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management. Springer
2. Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

## DISCIPLINE SPECIFIC ELECTIVE

### Paper -VII

#### INTRODUCTION TO GEOPHYSICS

(CREDITS: THEORY-4, PRACTICALS-2)

### THEORY LECTURES

#### Unit 1: Geology and Geophysics

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

#### Unit 2: General and Exploration geophysics

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

#### Unit 3: Geophysical field operations

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

#### Unit 4: Application of Geophysical methods

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

#### Unit 5: Geophysical anomalies

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

#### Unit 6: Integrated geophysical methods

Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

## **PRACTICALS**

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

### **SUGGESTED READINGS:**

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

### **SKILL ENHANCEMENT COURSE FIELD GEOLOGY -I (Basic field training) (CREDITS: 2)**

Unit 1: Orientation of Topographic sheet in field, marking location in toposheet, Bearing (Front and back). Concepts of map reading, Distance, height and pace approximation  
Unit 2: Identification of rock types in field; structures and texture of rocks, Use of hand lense  
Unit 3: Basic field measurement techniques: Bedding dip and strike, Litholog measurement  
Unit 4: Reading contours and topography

### **SKILL ENHANCEMENT COURSE FIELD GEOLOGY -II (Geological Mapping) (CREDITS: 2)**

Unit 1: Geological mapping, stratigraphic correlation  
Unit 2: Primary (scalars and vectors) and secondary structures (linear and planar)  
Unit 3: Trend, plunge, Rake/Pitch  
Unit 4: Stereoplots of linear and planar structures, Orientation analyses

**SKILL ENHANCEMENT COURSE**  
**FIELD GEOLOGY -III**  
(Economic Geology field)  
(CREDITS: 2)

**Module I**

Unit 1: Visit to any mineral deposit

Unit 2: Mode of occurrence of ore, Ore mineralogy

Unit 3: Ore-Host rock interrelation

Unit 4: Ore formation process

Unit 5: Basic techniques of surveying, concept of outcrop mapping

**Module 2**

Unit 1: Visit to underground or open cast mine

Unit 2: Practical experience of mining methods

Unit 3: Underground mapping/ Bench mapping

Unit 4: Isopach and Isochore maps

**SKILL ENHANCEMENT COURSE**  
**FIELD GEOLOGY -IV**  
(Himalayan Geology field)  
(CREDITS: 2)

Identification and characterization of major structural boundaries in Himalaya viz. MBT, MFT etc.

or

Field along any suitable transect of Himalayan foreland

or

Field transect in Siwalik

or

Identification of Himalayan and pre-Himalayan elements

**SKILL ENHANCEMENT COURSE**  
**FIELD GEOLOGY -V**  
(Precambrian Geology field)  
(CREDITS: 2)

Field transect in any Precambrian terrain

Study of craton ensemble including basic intrusive suites

Precambrian sedimentary basin

Basement-Cover relation in: a. fold belts, b. sedimentary successions

**SKILL ENHANCEMENT COURSE**  
**FIELD GEOLOGY - VI**  
(Visit to Engineering Project sites)  
(CREDITS: 2)

Unit 1: Geological mapping of a project site (Dam sites, Tunnel alignments etc)

Unit 2: On site visit & to study various geotechnical aspects related to the project site.

Unit 3: Identification of geotechnical problems of a project site and remedial measures to be taken.

Unit 4: Identification of environmental problems of a project site and remedial measures to be taken.

Unit 5: Computation of rock mass Properties (RQD, RSR, RMR & Q) in the field.

Unit 6: Identification of potential suspected/probable sites of Natural Disaster and suggestions about corrective/preventive measures.

**SKILL ENHANCEMENT COURSE**  
**FIELD GEOLOGY -VII**  
(Stratigraphy and paleontology-related field)  
(CREDITS: 2)

Field training along Phanerozoic basin of India

Documentation of stratigraphic details in the field

Collection of sedimentological, stratigraphic and paleontological details and their representation

Facies concept and its spatio-temporal relation (Walther's Law) and concept of facies distribution at basinal-scale

Fossils sampling techniques and their descriptions

**SKILL ENHANCEMENT COURSE**  
**PROJECT WORK -VIII**  
(CREDITS: 2)