

**CORE COURSE: GEOLOGY****Paper -I****EARTH SYSTEM SCIENCE**

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 48      MARKS: 50+ IA 15=65

**Unit 1: Earth as a planet****Lectures: 7      Marks: 6**

Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography.

Introduction to various branches of Earth Sciences.

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: Earth's magnetic field****Lectures: 6      Marks: 6**

Earth's magnetic field

Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere

Convection in Earth's core and production of its magnetic field

Mechanical layering of the Earth.

**Unit 3: Plate Tectonics****Lectures: 10      Marks: 12**

Concept of plate tectonics, sea-floor spreading and continental drift

Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs

Origin of oceans, continents, mountains and rift valleys

Earthquake and earthquake belts

Volcanoes- types, products and their distribution.

**Unit 4: Hydrosphere and Atmosphere****Lectures: 7      Marks: 6**

Oceanic current system and effect of Coriolis force

Concepts of eustasy

Land-air-sea interaction

Wave erosion and beach processes

Atmospheric circulation

Weather and climatic changes

Earth's heat budget.

**Unit 5: Soil****Lectures: 2      Marks: 03**

Soils- processes of formation, soil profile and soil types.

**Unit 6: Understanding the past from stratigraphic records****Lectures: 7      Marks: 8**

Nature of stratigraphic records

Standard stratigraphic time scale and introduction to the concept of time in geological studies

Introduction to geochronological methods and their application in geological studies

History of development in concepts of uniformitarianism, catastrophism and neptunism

Laws of superposition and faunal succession

Introduction to geology and geomorphology of Indian subcontinent.

**Unit 7: Cosmic abundance of elements****Lectures: 9 Marks:8**

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

**Internal Assessment****Marks:15****PRACTICALS:****Marks : 35**

Study of major geomorphic features and their relationships with outcrops through physiographic models.  
 Detailed study of topographic sheets and preparation of physiographic description of an area  
 Study of soil profile of any specific area  
 Study of distribution of major lithostratigraphic units on the map of India  
 Study of distribution of major dams on map of India and their impact on river systems  
 Study of major ocean currents of the World  
 Study of seismic profile and its interpretation  
 Viva + Practical Note Book

**Marks :25****Marks: 05****IA****Marks 5****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: 48 MARKS: 50+ 15=65****Unit 1: Crystallography****Lectures: 12 Marks: 13**

Elementary ideas about crystal morphology in relation to internal structures  
 Crystal parameters and indices  
 Crystal symmetry and classification of crystals into six systems and 32 point groups

**Unit 2: Crystal symmetry and projections****Lectures: 12 Marks: 12**

Elements of crystal chemistry and aspects of crystal structures  
 Stereographic projections of symmetry elements and forms

**Unit 3: Rock forming minerals****Lectures: 12    Marks:13**

Minerals - definition and classification, physical and chemical properties

Composition of common rock-forming minerals

Silicate and non-silicate structures; CCP and HCP structures

**Unit 4: Properties of light and optical microscopy****Lectures: 12    Marks:12**

Nature of light and principles of optical mineralogy

Introduction to the petrological microscope and identification of common rock-forming minerals

**Internal Assessment****Marks:15****PRACTICALS:****Marks: 35**

Observation and documentation of symmetry of crystals and crystallographic projection.

**Marks:08**

Study of physical properties of minerals in hand specimen

**Marks:08**

Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite

Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.

Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite

Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite,

Gypsum, Apatite.

Study of some key silicate minerals under optical microscope and their characteristic properties

**Marks:10**

Viva + Practical Note Book

**Marks: 04****IA****Marks: 05****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: 48      MARKS: 50+ IA 15=65

**Unit 1: Concepts of geochemistry** **Lectures: 08**    **Marks:7**

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** **Lectures: 10**    **Marks:10**

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

**Unit 3: Element transport** **Lectures: 12**    **Marks:12**

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

**Unit 4: Geochemistry of solid Earth** **Lectures: 12**    **Marks: 12**

The Solid Earth – geochemical variability of magma and its products.  
 The Earth in the solar system, the formation of solar system  
 Composition of the bulk silicate Earth  
 Meteorites

**Unit 5: Geochemical behavior of Si, Al, K, Na, Fe, Ca, Mg** **Lectures: 06**    **Marks: 7**

**Internal Assessment** **Marks: 15**

**PRACTICALS:** **Marks : 35**

Types of geochemical data analysis and interpretation; of common geochemical plots. **Marks:10**  
 Geochemical analysis of geological materials. **Marks:08**  
 Geochemical variation diagrams and its interpretations. **Marks:08**  
 Viva + Practical Note Book **Marks: 04**  
**IA** **Marks 5**

**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: 48      MARKS: 50+ IA 15=65

**Unit 1: Structure and Topography****Lectures: 06      Marks:6**

Topographic and structural maps; Important representative factors of the map, Effect of topography on outcrop pattern of planar structural features.

**Unit 2: Stress and strain in rocks****Lectures: 10      Marks:10**

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

Planar and linear structures; Concept of dip and strike; Outcrop patterns of different structures. Unconformity and its types

**Unit 3: Folds****Lectures: 12      Marks:12**

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

**Unit 4: Foliation and lineation****Lectures: 10      Marks:10**

Description and origin of foliations: axial plane cleavage and its tectonic significance

Description and origin of lineation and relationship with the major structures

**Unit 5: Fractures and faults****Lectures: 10      Marks:10**

Geometric and genetic classification of fractures and faults

Effects of faulting on the outcrops

Geologic/geomorphic criteria for recognition of faults and fault plane solutions

**Internal Assessment****Marks:15**

**PRACTICALS:****Marks : 35**

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.) **Marks: (5 X 5)= 25**

Viva + Practical Note Book

**Marks: 05****IA****Marks: 05****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

**GENERIC ELECTIVE -I****ESSENTIALS OF GEOLOGY**

(CREDITS: THEORY-4, PRACTICAL-2)

THEORY LECTURES: 48 MARKS: 50+ IA 15=65

**Unit 1:** Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences**Lectures: 04 Marks:04****Unit 2:** Earth in the solar system, origin**Lectures: 10 Marks:12**

Earth's size, shape, mass, density, rotational and evolutionary parameters

Solar System- Introduction to Various planets - Terrestrial Planets

Solar System- Introduction to Various planets - Jovian Planets

Internal constitution of the earth - core, mantle and crust

**Unit 3:** Convections in the earth's core and production of magnetic field **Lectures: 10 Marks:10**

Composition of earth in comparison to other bodies in the solar system

**Unit 4:** Origin and composition of hydrosphere and atmosphere **Lectures: 12 Marks:12**

Origin of biosphere

Origin of oceans, continents and mountains

**Unit 5:** Age of the earth; Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils **Lectures: 12 Marks:12****Internal Assessment****Marks:15**

**PRACTICALS:****Marks: 35**

1. Study of major geomorphic features and their relationships with outcrops through physiographic models.
2. Detailed study of topographic sheets and preparation of physiographic description of an area
3. Study of soil profile of any specific area
4. Study of distribution of major lithostratigraphic units on the map of India
5. Study of distribution of major dams on map of India and their impact on river systems
6. Study of major ocean currents of the World
7. Study of seismic profile of a specific area and its interpretation

**Marks: 25**

Viva + Practical Note Book

**Marks: 05****IA****Marks: 05****SUGGESTED READINGS:**

1. Holmes' Principles of Physical Geology. 1992. Chapman & Hall.
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*, Prentice Hall.

**GENERIC ELECTIVE -II****ROCKS AND MINERALS**

(CREDITS: THEORY-4, PRACTICAL-2)

THEORY LECTURES: 48      MARKS: 50+ IA 15=65

**Unit 1:** Minerals-Definitions, Physical properties of minerals      **Lectures: 08    Marks:6**  
 Mineralogical structure of earth, planetary minerals and native elements

**Unit 2:** Mineral structures      **Lectures: 10    Marks:12**  
 Mineralogy of the Earth's crust, mantle and core

**Unit 3:** Nature of light and principles of optical mineralogy      **Lectures: 10    Marks:12**  
 Optical classification of minerals.  
 An overview of environmental and radiation mineralogy, biomineralisation and gemology.

**Unit 4:** Rocks- Definitions and types, Basics of rock formation.      **Lectures: 20    Marks:18**  
 Igneous rock- magma generation and differentiation  
 Sedimentary rocks- surface processes and sedimentary environments  
 Metamorphic rocks- chemical system and types of metamorphism  
 Rock cycle-interactions between plate tectonics and climate systems

**Internal Assessment****Marks:15**

**PRACTICALS:**

1. Study of physical properties of minerals
2. Introduction to optical microscopy
3. Study of optical properties of minerals
4. Study of physical properties of rocks
5. Study of optical properties of rock under thin sections
6. Understanding crystal symmetry via wooden models
7. Stereographic projection of mineral faces

Viva + Practical Note Book

**Marks: 35**

**Marks: 30**

**Marks: 05**

**SUGGESTED READINGS:**

1. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.
2. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and company, New York.



**CORE COURSE: GEOLOGY****Paper -V****Igneous Petrology**

(CREDITS: THEORY-4, PRACTICALS-2)

**THEORY**

LECTURES: 60      MARKS: 50+ IA 15=65

**Unit 1: Introduction;** Introduction to petrology: Heat flow, geothermal gradients through time, General idea about the composition constitution and nature of magmas and lavas. Generation of magmas.  
Lectures:12 ; Marks:08

**Unit 2: Igneous Rocks,** Classification of igneous rocks, Textures and structures of igneous rocks. Mode of occurrence of Igneous rocks  
Lectures:12 ; Marks:10

**Unit 3:** Phase diagrams and petrogenesis; Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic Magmas. Reaction principles and the crystallization of magmas. Evolution of magmas. Primary and derivative magmas. Role of volatiles in magma. Concept of conanguity and variation diagrams.  
Lectures:16 ; Marks:14

**Unit 4:** Magmatism in different tectonic settings; Magmatism in the oceanic domains (MORB, OIB) Magmatism along the plate margins (Island arcs/continental arcs)  
Lectures:10 ; Marks:08

**Unit 5:** Petrogenesis of Igneous rocks, Petrogenesis of Felsic and Mafic igneous rocks, Komatiites, Granitoides, Basalt, Gabbros, Alkaline rocks, kimberlites, lamproites, **Sylhet Traps and Abor Volcanics.**  
Lectures:10 ; Marks:10

**PRACTICALS:**

MARKS: 30+ IA 05=35

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite.

**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**

#### **Sedimentary Petrology**

(CREDITS: THEORY-4, PRACTICALS-2)

#### **THEORY**

LECTURES: 60      MARKS: 50+ IA 15=65

**Unit 1:** Origin of sediments; Weathering and sedimentary flux: Physical and chemical weathering, soils and paleosols; **Provenance and Heavy minerals.**      Lectures:12 ; Marks:10

**Unit 2:** Sediment granulometry, Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric      Lectures:10 ; Marks:08

**Unit 3:** Sedimentary textures, structures and environment, Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition. Paleocurrent analysis- Paleocurrents for different sedimentary environments, Sedimentary structure- Primary and syn-sedimentary structures  
Lectures:14 ; Marks:12

**Unit 4:** Varieties of sedimentary rocks, Siliciclastic rocks: Conglomerates, sandstones, mudrocks. Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation.      Lectures:12 ; Marks:10

**Unit 5:** Diagenesis, Concepts of diagenesis, Stages of diagenesis, **Compaction, Cementation, lithification and authigenesis.**      Lectures:12 ; Marks:10

#### **PRACTICALS:**

MARKS: 30+ IA 05=35

**Study of sedimentary rocks in hand specimens,**

**Study of sedimentary rocks in thin sections,**

**Study of texture in thin sections and hand specimens,**

**General overview on depositional conditions and provenance from the study of framework, cement and matrix of given sedimentary rock in thin section.**

#### **SUGGESTED READINGS:**

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

**CORE COURSE: GEOLOGY****Paper -VII****Palaeontology**

(CREDITS: THEORY-4, PRACTICALS -2)

**THEORY**

LECTURES: 60      MARKS: 50+ IA 15=65

**Unit 1:** Definition, Branches, scope and application of palaeontology. Fossilization and fossil record, Nature and importance of fossil record; Fossilization processes and modes of preservation. Lectures:06 ; Marks:06

**Unit 2:** Taxonomy and Species concept, Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record. Lectures:10 ; Marks:08

**Unit 3:** Invertebrates, Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance, Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications, Functional adaptation in trilobites and ammonoids. Lectures:12 ; Marks:10

**Unit 4:** Vertebrates, Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs Evolution of horse and intercontinental migrations. Human evolution. Lectures:12 ; Marks:10

**Unit 5.** Introduction to Paleobotany, Gondwana Flora, Introduction to Ichnology. Lectures:08 ; Marks:06

**Unit 6:** Application of fossils in Stratigraphy, Biozones, index fossils, correlation, Role of fossils in sequence stratigraphy; Fossils and paleoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers; Paleoecology – fossils as a window to the evolution of ecosystems. Lectures:12 ; Marks:10

**PRACTICALS:**

MARKS: 30+ IA 05=35

Study of fossils showing various modes of preservation;

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

**SUGGESTED READINGS**

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: 60      MARKS: 50+ IA 15=65

**Unit 1:** Metamorphism: controls and types. Definition of metamorphism. Factors controlling metamorphism Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism. **Regional metamorphism of argillaceous, calcareous and basic rocks**

Lectures:14 ; Marks:12

**Unit 2:** Metamorphic facies and grades, Index minerals, Chemographic projections, Metamorphic zones and isogrades. Concept of metamorphic facies and grade Mineralogical phase rule of closed and open system, Structure and textures of metamorphic rocks, **General idea about the thermodynamic consideration in metamorphic rock, Equilibrium in metamorphism. Univariant and bivalent reaction and their significance.**

Lectures:14 ; Marks:12

**Unit 3:** Metamorphism and Tectonism, Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde)

Lectures:12 ; Marks:10

**Unit 4:** Migmatites and their origin, Metasomatism and role of fluids in metamorphism

Lectures:10 ; Marks:08

**Unit 5:** Metamorphic rock associations- schists, gneisses, khondalites, charnockites, blue schists, eclogites, Khasi greenstone, Slate, phyllite, schist, quartzite, marble amphibolites, granulite, and hornfels.

Lectures:10 ; Marks:08

**PRACTICALS:**

MARKS: 30+ IA 05=35

**Study of metamorphic rocks in hand specimens,**

Study of metamorphic rocks in thin sections,  
Study of texture in thin section and hand specimens,  
Study of metamorphic phase diagrams

### **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: 60      MARKS: 50+ IA 15=65

**Unit 1:** Principles of stratigraphy, Fundamentals of litho-, bio- and chrono-stratigraphy, Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy).      Lectures:10 ; Marks:06

**Unit 2:** Code of stratigraphic nomenclature, International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP). Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy, Magnetostratigraphy, Sequence stratigraphy and their subdivisions with Indian examples.

Lectures:10 ; Marks:08

**Unit 3:** Principles of stratigraphic analysis Facies concept in stratigraphy. Walther's Law of Facies. Concept of paleogeographic reconstruction      Lectures:06 ; Marks:06

**Unit 4:** Physiographic and tectonic subdivisions of India, Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield. Introduction to Proterozoic basins of India. Geology of Vindhyan and Cudappah basins of India.

Lectures:08 ; Marks:08

**Unit 5:** Phanerozoic Stratigraphy of India. Paleozoic Succession of Kashmir and its correlatives from Spiti and Zaskar Stratigraphy. Structure and hydrocarbon potential 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.

Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and, Saurashtra basins and their potential for hydrocarbon exploration

Lectures:12 ; Marks:10

**Unit 6:** Volcanic provinces of India

a. Deccan, b. Rajmahal, c. Sylhet Trap

Lectures:07 ; Marks:06

**Unit 7:** Stratigraphic boundaries. Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary.

Lectures:07 ; Marks:06

**PRACTICALS:**

MARKS: 30+ IA 05=35

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 and Oceanography**

(CREDITS: THEORY-4, PRACTICALS -2)

**THEORY**

LECTURES: 60

MARKS: 50+ IA 15=65

**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

Lectures:12 ; Marks:10

**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.

Lectures:12 ; Marks:10

**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.

Lectures:12 ; Marks:10

**Unit 4:** 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.

Lectures:12 ; Marks:10

**Unit 5:** Fundamentals of Oceanography:

- General idea of oceanography. Theories on origin of ocean basins.
- Branches of oceanography: Biological oceanography, chemical oceanography, Geological oceanography and physical oceanography. Palaeo-oceanography
- Physical properties of oceans:  
Temperature-salinity structure, mixing of waters, surface waves, internal waves, surface tides, internal tides and currents. Pleomorphic aspects of oceans

Lectures:12 ; Marks:10

**PRACTICALS:**

MARKS: 30+ IA 05=35

Preparation and interpretation of water level contour maps and depth to water level maps

Study, preparation and analysis of hydrographs for differing groundwater conditions

Water potential zones of India (map study).

Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams)

Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

**SUGGESTED READINGS:**

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. L

**GENERIC ELECTIVE -III**

Physics and Chemistry of Earth

(CREDITS: THEORY-4, PRACTICAL-2)

**THEORY**

LECTURES: 60

MARKS: 50+ IA 15=65

**Unit 1:** Earth: surface features, Continents, continental margins, oceans

Lectures:12 ; Marks:10

**Unit 2:** Earth's interior - variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities. Concepts of Isostasy; Airy and Pratt Model Core: Seismological and other geophysical constraints. The geodynamo - Convection in the mantle.

Lectures:12 ; Marks:10

**Unit 3:** Elements of earth's magnetism. Secular variation and westward drift. Solar activity and magnetic disturbance.

Lectures:10 ; Marks:08

**Unit 4:** Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system / planet earth, Geochemical classification of elements. Earth accretion and early differentiation, Isotopes and their applications in understanding Earth processes., Stable isotopes: Stable isotope fractionation. Oxygen isotopes Sublithospheric Mantle (Mineralogy/phase transitions).

Lectures:14 ; Marks:12

**Unit 5:** Environmental geochemistry Geological disposal of nuclear waste. Lead in environment and effect of lead on human health.

Lectures:12 ; Marks:10

### **PRACTICALS:**

MARKS: 30+ IA 05=35

1. Projection of major elements on binary and triangular diagrams for rock classification
2. Projection of major element data on Harker's diagram to characterize magmatic differentiation
3. Study of trace elements through a) Projection of chondrite/primitive normalized trace elements to characterize sources b) Projection of trace elements on tectonic discrimination diagrams
4. Understanding Earth structure through behavior of seismic wave propagation
5. Problems on isostasy

### **SUGGESTED READINGS:**

1. Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
2. Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
3. Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill
4. Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
5. Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
6. Steiner, E. (2008). The chemistry maths book. Oxford University Press.
7. Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press.

## **GENERIC ELECTIVE -IV**

### **Earth Resources**

(CREDITS: THEORY-4, PRACTICAL-2)

### **THEORY**

LECTURES: 60      MARKS: 50+ IA 15=65

**Unit 1:** Earth Resources, Resource reserve definitions; mineral, energy and water resources in industries. Historical perspective and present. A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies

Lectures:15 ; Marks:12



**Unit 2:** Definition of Energy: Primary and Secondary Energy Difference between Energy, Power and Electricity Renewable and Non-Renewable Sources of Energy. The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy.

Lectures:15 ; Marks:12

**Unit 3:** Major Types and Sources of Energy, Resources of Natural Oil and Gas. Coal and Nuclear Minerals. Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy.

Lectures:15 ; Marks:14

**Unit 4:** Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave-General Principles. Ground water resources and its role in economic development of a country Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.

Lectures:15 ; Marks:14

**PRACTICALS:**

MARKS: 30+ IA 05=35

1. Plotting of major Indian oil fields on map of India
2. Problems related to hydroelectric power generation
3. Problems related to assessment of possible oil exploration site from geological maps
4. Problems related to energy demand projection of India and possible mitigation pathways
5. Problems related to biofuel

**SUGGESTED READINGS:**

1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill
2. Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M. A. Prelas. 2009, Springer
4. Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.
5. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.