

## **M. Sc. GEOLOGY SYLLABUS**

M.Sc. Geology course of Two Years duration is divided into Four Semesters.

- \* Each Semester is of 300 marks.
- \* Each Semester will have Four Theory Papers, each of 50 marks.
- \* Each Semester will have Four Practical Papers, related to four Theory Papers, each of 25 marks.

### **Teaching Work-load :**

- \* Each Theory Paper will have four lectures, each of 60 minutes duration, per week.
- \* Each Practical Paper will have six lectures, each of 60 minutes duration, per week.
- \* **Each Theory Paper will have one Tutorial, each of 60 minutes duration, per week.**

### **Geological Study - Tours/ Mine Training Programme/ Field Work**

- \* The students will have to undertake Geological Study- Tours/ Field Mapping Tours for at least eight days in Semester- II. Students will have to submit a report about the same. This will be compulsory and carries mark. These marks will be included in the Practical.
- \* The students will have to under go mine training programme/ On- site Training/ project work Engineering tours for at least 12 days in Semester - IV. Students will have to submit a report about the same. This will be compulsory and will carry marks. These marks will be included in the Practical.

### **Seminars and Tutorials**

- Regular Seminars and Tutorials based on each paper will be conducted in the Department from time to time. It is compulsory for every student. Students not completing their seminars and tutorials will not be allowed to appear for practical examination.

**Theory/ Practical Papers****Page No****SEMESTER I**

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|---|---|
| Theory paper I : Mineralogy and Crystallography | 2 |
| Theory paper II : Igneous Petrology             | 3 |
| Theory paper III : Metamorphic Petrology        | 4 |
| Theory paper IV : Sedimentary Petrology         | 5 |

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|--|---|
| Practical paper I : Mineralogy and Crystallography | 2 |
| Practical paper II : Igneous Petrology             | 3 |
| Practical paper III : Metamorphic Petrology        | 4 |
| Practical paper IV : Sedimentary Petrology         | 5 |

**SEMESTER II**

|  |   |
|--|---|
| Theory paper V : Stratigraphy and Paleontology                             | 6 |
| Theory paper VI : Structural Geology and Tectonics                         | 7 |
| Theory paper VII : Remote Sensing and Geomorphology                        | 8 |
| Theory paper VIII : Ore Geology, Instrumentation and Analytical Techniques | 9 |

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|---|---|
| Practical paper V : Stratigraphy and Paleontology                             | 6 |
| Practical paper VI : Structural Geology and Tectonics                         | 7 |
| Practical paper VII : Remote Sensing and Geomorphology                        | 8 |
| Practical paper VIII : Ore Geology, Instrumentation and Analytical Techniques | 9 |

**SEMESTER III**

|   |    |
|---|----|
| Theory paper IX : Hydrogeology            | 10 |
| Theory paper X : Fuel Geology             | 11 |
| Theory paper XI : Geophysical Exploration | 12 |
| Theory paper XII : Environmental Geology  | 13 |

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|--|----|
| Practical paper IX : Hydrogeology            | 10 |
| Practical paper X : Fuel Geology             | 11 |
| Practical paper XI : Geophysical Exploration | 12 |
| Practical paper XII : Environmental Geology  | 13 |

**SEMESTER IV**

|   |    |
|---|----|
| Theory paper XIII : Mining Geology  | 14 |
| Theory paper XIV : Geochemistry   | 15 |
| Theory paper XV : Engineering Geology                                       | 16 |
| Theory paper XVI : Statistical Geology and Computer Applications in Geology | 17 |

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| Practical paper XIII : Mining Geology  | 14 |
| Practical paper XIV : Geochemistry   | 15 |
| Practical paper XV : Engineering Geology                                       | 16 |
| Practical paper XVI : Statistical Geology and Computer Applications in Geology | 17 |

# SEMESTER- I

## THEORY PAPER I- MINERALOGY AND CRYSTALLOGRAPHY

**Marks – 50**

**Total Periods – 40**

### UNIT –I

Silicate structures of minerals; physical and chemical properties of minerals. (5 Periods)

### UNIT – II

Structural formulae, classification, atomic structure, polymorphs/structural states, chemistry, substitution of elements/solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations. of the following group of rock- forming minerals - olivine, humite, garnet, kyanite, pyroxene, amphibole, talc, mica, chlorite, feldspar, cordierite, kaolinite, serpentinite feldspathoids, alumino-silicate and metallic oxides. (10 Periods)

### UNIT III

Birefringence, pleochroism and interference phenomena in minerals; extinction angles; optical indicatrix; concept of uniaxial and biaxial indicatrix; dispersion in minerals; optical anomalies; and optical accessories like quartz, mica and gypsum plate. (10 Periods)

### UNIT- IV

Concept of symmetry; space lattice and point groups; 32 classes of symmetry. (10 Periods)

### UNIT –V

Goniometry, twinning and; X- rays and its application in crystallography (5 Periods)

## PRACTICAL PAPER I- MINERALOGY AND CRYSTALLOGRAPHY

**Marks- 25**

**Total 6 Periods/ week**

Study of rock- forming minerals in hand specimen; study of rock- forming minerals in thin sections; optical properties of uniaxial and biaxial minerals- pleochroism, extinction, interference colours and optical angle; calculation of chemical formula of minerals and its plotting; twin laws; anorthite content of plagioclases; 32 classes of crystal symmetry; method of plotting of poles by stereographic projections.

### RECOMMENDED BOOKS

1. Dana:- Elements of Mineralogy
2. Deer, Howie and Zussman:- Rock forming minerals
3. Kerr:- Optical mineralogy
4. Winchell:- Elements of Optical Mineralogy (Part I, II and III)
5. Wahlstrom:- Optical crystallography
6. Phillipps:- An introduction to crystallography
7. Barry and Mason:- Mineralogy
8. Klein and Hubert:-Manual of mineralogy
9. Spear, F. S.: -Mineralogical phase equilibrium and Pressure- Temperature- Time paths
10. Phillipps, W. R. and Guffen, D. T.: - Optical mineralogy

## **THEORY PAPER II- IGNEOUS PETROLOGY**

**Marks- 50**

**Total Periods- 40**

### **UNIT- I**

Defination of Magma, constitution of magmas, generations of Magmas, source rock composition upper mantle and lower crust; nature of magma and evolution of magma.

(5 Periods)

### **UNIT- II**

Phase equilibrium of unicomponent, binary, ternary and quaternary silicate systems; its relation to magma genesis and crystallization in the light of modern experimental works.

(15 Periods)

### **UNIT- III**

Criteria for classification of the igneous rocks; CIPW- norms, Niggli values, IUGS classification.

(8 Periods)

### **UNIT- IV**

Petrology, geochemistry and genesis of major igneous rocks types of mafic ultramafic, alkaline rocks, ophiolites, carbonatites, lamprolite, kimberlite ,pegmatites and lamprophyres;.

(12 Periods)

### **UNIT- V**

Crystallization of basaltic and granitic magmas; mid oceanic ridge volcanism, continental flood basalts, Deccan basalt, basalt magmatism associated with subduction zone.

(10 Periods)

## **PRACTICAL PAPER II- IGNEOUS PETROLOGY**

**Marks 25**

**Total 6 Periods/ week**

Study of igneous rocks in hand specimen; study of igneous rocks in thin sections; structures and textures in igneous rocks; calculation of CIPW norms and Niggli values; plotting of chemical data on different variation diagrams for evaluation of magma and rock types; field mapping in basaltic terrain; preparation of igneous rock slides.

### **RECOMMENDED BOOKS**

1. Barth:- Theoretical Petrology
2. Bowen:- Evolution of Igneous Rocks
3. Turner and Verhoogan:- Igneous and Metamorphic Petrology
4. Carmicheal, Turner and Verhoogan:- Igneous Petrology
5. Hatch, Wells and Wells:- Petrology of Igneous rocks
6. Brain:- Igneous Petrology
7. Best:-Igneous Petrology
8. Mc Berney :-Igneous Petrology
9. Bose:-Igneous Petrology

## **THEORY PAPER III- METAMORPHIC PETROLOGY**

**Marks- 50**

**Total Periods- 40**

### **UNIT I**

Types of metamorphism; Depth zones, metamorphic grades; mineralogical phase rule of closed and open systems; application of phase rule.

( 5 Periods)

### **UNIT II**

Role of temperature, pressure and fluids in metamorphism; a detailed description of each facies of low pressure, medium to high pressure and very high pressure with special reference to characteristic metamorphic zones and subfacies;

( 10 Periods)

### **UNIT III**

Progressive, contact and regional metamorphism of quartzofelspathic, argillaceous and basic igneous rocks.

( 10 Periods)

### **UNIT IV**

Metamorphic differentiation, metasomatism; anatexis and origin of migmatites; regional metamorphism and pair metamorphic belts in reference to plate tectonics.

( 10 Periods)

### **UNIT V**

Ocean floor metamorphism, metamorphism related to ophiolites, metamorphism and continental collision petrogenetic significance of textures and structures

( 5 Periods)

## **PRCTICAL PAPER III- METAMORPHIC PETROLOGY**

**Marks- 25**

**Total 6 Periods/ week**

Study of metamorphic rocks in hand specimen; study of metamorphic rocks in thin sections; structures and textures in metamorphic rocks; interpretation of reaction texture; plotting of chemical data on ACF, AKF and AFM diagrams; preparation of metamorphic rock slides.

### **RECOMMENDED BOOKS**

1. Harker:- Metamorphism
2. Turner:- metamorphic Petrology
3. Winkler:- Petrogenesis of metamorphic rocks
4. Miashiro:- Metamorphism and metamorphic rocks
5. Turner and Verhoogan:- Igneous and Metamorphic Petrology
6. Philipots:- Igneous and Metamorphic Petrology
7. Bucher and Feg:- Petrogenesis of metamorphic rocks

## **THEORY PAPER IV- SEDIMENTARY PETROLOGY**

**Marks 50**

**Total Periods- 40**

### **UNIT I**

Processes of transport and formation of sedimentary rocks; classification of sedimentary rocks; sedimentary textures and structures.

(8 Periods)

### **UNIT II**

Sedimentary environments and facies; continental environments - alluvial, lacustrine, desert- aeolian and glacial sedimentary systems. Marginal marine environments – deltaic, beach and barrier- islands, estuarine and lagoonal, tidal –flat system

(8 Periods)

### **UNIT III**

Grain size, Textural Parameters and their Significance. Textural and compositional maturity. Petrography and Diagenesis origin of Sandstones, Limestones and Mudrocks.

Evolution of sedimentary basins- tectonics and sedimentation

(8 Periods)

### **UNIT IV**

Heavy Minerals and their Importance in Determination of Provenance. Deep sea basins; clastic petrofacies; palaeoclimate and palaeoenvironment analysis

(8 Periods)

### **UNIT V**

Major diagenetic processes; diagenetic environments; Petrogenetic significance of textures and structures, Major Carbonate Minerals; Carbonate Grains of Biological origin.

(8 Periods)

## **PRACTICAL PAPER IV- SEDIMENTARY PETROLOGY**

**Marks- 25**

**Total 6 Periods/ week**

Study of sedimentary rocks in hand specimen; study of sedimentary rocks in thin section; study of primary, Grain-size Analysis by sieving Method: Plotting of size-distribution data as Frequency and Cumulative. Curves; Computation of Statistical Parameters and Interpretation. Heavy Mineral Separation; their Microscopic Characters, Graphic Representation and Interpretation. secondary and biogenic sedimentary structures in hand specimen; aerial photographs and field exercises related to palaeocurrent data from different environments; exercises related to analysis and interpretation of depositional sedimentary environments; determination of porosity in clastic and carbonate rocks; staining and mineral identification in carbonate rocks; detailed study of diagenetic features in thin sections; preparation of thin section of sedimentary rocks.

### **RECOMMENDED BOOKS**

1. Allen, J.R.L.: -Principles of physical sedimentation
2. Nichols, G.: -Sedimentology and Stratigraphy
3. Reading, H.G.: -Sedimentary environments
4. Reineck, H.R. and Singh, I.B.: -Depositional sedimentary environments
5. Miall, A.D.: -Principles of sedimentary basin analysis
6. Eincele, G.: -Sedimentary basins
7. Pomerol, C.: -The Cenozoic Era: Tertiary and Quaternary
8. Tucker, M.: -Techniques in sedimentology

## SEMESTER- II

### THEORY PAPER V- STRATIGRAPHY AND PALAEOONTOLOGY

Marks- 50

Total Periods- 40

#### UNIT I

Approaches to measurements of Geological time. Concepts of Sequence stratigraphy; brief ideas of quantitative-, magneto-, seismic-, chemo- and event stratigraphy.. Stratigraphic correlations. stratigraphic code. (4 Periods)

#### UNIT II

Dharwar classification, younger and older supracluster, Southern Granulite terrain, younger and older supracluster and Singhbhum-Chhotanagpur-Orissa Belt. Proterozoic Cuddapah basins. Precambrian-Cambrian boundary. (9 Periods)

#### UNIT III

Stratigraphy and correlation of the Gondwana rocks; Mesozoics of Peninsular India; Cenozoic stratigraphy ,Problems of Cretaceous- Eocene boundary of India; Tertiary rocks of India and their correlation; Quaternary stratigraphy of India;. Cretaceous-Tertiary boundary. Palaeogene and Neogene systems, Epoch boundaries of the Cenozoic in India.Stratigraphy, facies, and fossil contents of the Palaeozoic rock formations of India. Palaeozoic of Himalayas Permian-Triassic boundary. (9 Periods)

#### UNIT IV

Origin and evolution of fossils, Collection, preparation, preservation and maintenance of palaeontological record; microfossils; types of microfossils-foramenifera, calcareous, nanno , silicious, phosphatic, organic walled , application of micropaleontology in ocean science, palynology and its application. (9 Periods)

#### UNIT V

Modern Taxonomy, Identification of fossils, Describing a fossil specimen, Ontogenic variation.

Trace fossils: Kinds and classification; their significance in palaeoenvironmental reconstruction.

Classification of Brachiopoda, Bivalvia, Ammonoidea and Cnidaria (corals) Evolutionary trends and Geological history of Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and Cnidaria (corals). Palaeoecology/Functional Morphology of Bivalves and Brachiopods. Evolution of man. (9 Periods)

### PRACTICAL PAPER V- STATIGRAPHY AND PALAEOONTOLOGY

Marks 25

Total 6 Periods/ week

Exercises on stratigraphic classification and correlation; study of palaeogeographic maps of all the geological periods; plotting of rock formations on maps; study of important genera of invertebrate, vertebrate and plant fossils; study of fossils in thin sections; study of microfossils.z

#### RECOMMENDED BOOKS

- 1.Krishnan, M. S.: - Geology of India and Burma
- 2.Wadia, D.N.: - Geology of India
- 3.Ravindrakumar: - historical Geology
- 4.Dunbar and Rogers: - Principles of Stratigraphy
- 5.Krumbein and Sloss: - Stratigraphy and Sedimentation
- 6.Willey,M. J.: - Stratigraphic principles and practice
- 7.Naqvi and Rodgers: - Precambrian Stratigraphy of India
- 8.Swinnerton:- Outlines of Paleontology
- 9.Moore, Lalicker and Higher: - Invertebrate Paleontology

## **THEORY PAPER VI- STRUCTURAL GEOLOGY AND TECTONICS**

**Marks 50**

**Periods- 40**

### **UNIT I**

Mechanical principles and properties of rocks and their controlling factors; theory of rock failure; concept of stress and strain; two dimensional strain and stress analysis; types of stress and strain ellipses and ellipsoids, their properties and geological significance; strain marks in naturally deformed rocks.

(8 Periods)

### **UNIT II**

Folds-

Geometric classification of folds; mechanics of folding and buckling; folding in shear zones; distribution of strains in folds; structural analysis in terrain with multiple deformation.

(8 Periods)

### **UNIT III**

Faults-

Causes and dynamics of faulting; strike- slip faults; normal faults; overthrust and nappe  
Fractures and joints- their nomenclature; age relationship; origin and significance, introduction to petrofabric analysis

(8 Periods)

### **UNIT IV**

Fundamental concepts of geotectonic; recent advances, pros and cons; dynamic evolution of continental and oceanic crust; tectonics of Precambrian orogenic belts of India; tectonic framework of India; seismicity in India

(8 Periods)

### **UNIT V**

Formation of mountain roots; anatomy of the orogenic belts; structure and origin of the Alpine-Himalayan belt, Appalachian- Caledonian belt, Andes and North- American Cordillera.

(8 Periods)

## **PAPER VI- STRUCTURAL GEOLOGY AND TECTONICS**

**Marks – 25**

**Total 6 Periods/ week**

Relation of structural- geology problems by orthographic and stereographic methods; completion of outcrops; drawing of structural sections and interpretation of geological maps; graphical solutions.

### **RECOMMENDED BOOKS**

1. Badgley, P.C. (1965): - Structure and Tectonics
2. Ramsay, S.G. (1967): - Folding and Fracturing of Rocks
3. Davis, G.R. (1984): - Structural Geology of Rocks and Region
4. Price, N.J. and Cosgrove, J.W. (1990): - Analysis of Geological Structures
5. Bayly, B.(1992): - Mechanics in Structural Geology
6. Moors, E. and Taiss, R.J. (1995) Tectonics
7. Keary, P and Vine, F.J. (1990); - Global Tectonics
8. Valdiya, K.S. (1998): - Dynamic Himalaya

## **THEORY PAPER VII- REMOTE SENSING AND GEOMORPHOLOGY**

**Marks 50**

**Periods- 40**

### **UNIT I**

Fundamental concepts of remote sensing; general idea about electromagnetic spectrum; spectral bands, resolutions and reflectance curves; interaction of EMR with atmosphere, rocks, minerals and soils; aerial photographs and their geometry; recognition of photo-elements; recent advancement and application  
(8 Periods)

### **UNIT II**

Satellite remote sensing; global and Indian space missions; different satellite exploration programs and their characteristics: LANDSAT, METEOSAT, SEASAT, SPOT and IRS; visual interpretation of satellite images; computer application in Remote sensing.  
(8 Periods)

### **UNIT III**

Imageries and IRS products; use of remote sensing in groundwater exploration, petroleum exploration, engineering geology; use of satellite images in monitoring natural hazards and environment.  
(8 Periods)

### **UNIT IV**

Dynamics of geomorphology; geomorphic processes and resulting landforms geomorphic features of Maharashtra and geomorphology of Indian sub continents;  
(8 Periods)

### **UNIT V**

Geomorphological mapping based on genesis of landforms; morphometric analysis and modeling terrain evaluation for strategic purpose; principles and applications of Geographic Information System.  
(8 Periods)

## **PRACTICAL PAPER VII- REMOTE SENSING AND GEOMORPHOLOGY**

**Marks- 25**

**Total 6 Periods/ week**

Study and nature of aerial photographs resolution, mosaics, symbols, gully, pattern and drainage analysis, image parallax; determination of scale, height, dip, slope, vertical exaggeration and image distortion; detailed study of imageries.

### **RECOMMENDED BOOKS**

1. Miller (1961): - - Photogeology
2. Sabbins (1985): - Remote Sensing- Principles and Applications
3. Ray (1969): - Aerial Photographs in Geological Interpretations
4. Drury (1987): - Image Interpretation in Geology
5. Moffitt and Mikhail (1980): - Photogrammetry
6. Lillesand and Kieffer (1987): - Remote Sensing and Image Interpretation
7. Pandey S.N. (1987) Principles and Application of Photogeology
8. Gupta (1990): - Remote Sensing Geology
9. Thornbury: - Principles in Geomorphology
10. Summerfield (2000): - Geomorphology and Global Tectonics

## **THEORY PAPER VIII-ORE GEOLOGY, INSTRUMENTATION AND ANALYTICAL TECHNIQUES**

**Marks- 50**

**Periods- 40**

### **UNIT I**

Modern concept of ore genesis; spatial and temporal distribution of ore deposits- a global perspective; processes of formations of ore mineral deposits; ore deposits and plate tectonics; mode of occurrence of ore bodies- morphology and relation of host rocks; texture, paragenesis and zoning of ores and their significance; concept of ore- bearing fluids, their origin and migration; wall- rock alteration; structural, physiochemical and stratigraphic control of ore localization. Geothermometry and geobarometry of ore assemblage. (8 Periods)

### **UNIT II**

Chemical composition of ores- bulk chemistry, trace elements; REE and isotopes (stable and radiogenic); organic matter in ores and their significance; petrological ore associations with Indian examples wherever feasible: Orthomagmatic ores of mafic- ultramafic associations - diamond in kimberlite; REE in carbonatites; Ti- V ores; chromite and PGE; Ni ores; Cyprus type Cu- Zn ores of silicic igneous rocks- Kiruna type Fe- P; pegmatites; greisens; skarn. Ore of sedimentary affiliation- chemical and clastic sedimentation; stratiform and stratabound ores deposits( Mn, Fe, non- ferrous ores); places; ores of metamorphic affiliation- metamorphism of ores; ore related to weathering- laterite, bauxite, Ni/ Au laterite. (8 Periods)

### **UNIT III**

Study of following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: iron, manganese, gold, aluminum, chromium, copper, lead, zinc, tin, tungsten, titanium, nickel, molybdenum; fuels: coal, petroleum and radioactive minerals, gemstones (8 Periods)

### **UNIT IV**

Sampling and sampling preparation; thin section and polished section making; dissolution procedures in geological and environmental samples; sample etching; staining and modal count techniques. (8 Periods)

### **UNIT V**

principles and geological application of cathodeluminescence, thermoluminescence; atomic absorption spectroscopy; inductively coupled plasma- atomic emission spectrometry, x- ray fluorescence spectrometry, scanning and transmission electron microscopy; electron- probe microanalysis; x- ray diffractometry; thermal ionization and gas source mass spectrometry. (8 Periods)

(8 Periods)

## **PRACTICAL PAPER VIII-ORE GEOLOGY, INSTRUMENTATION AND ANALYTICAL TECHNIQUES**

**Marks 25**

**Total 6 Periods/ week**

Megascopic study of structures and fabrics of different ores and their associations; mineralogical and textural studies of common ore minerals under petrological microscope and ore microscope; exercises on the determination of reflectivity and microhardness of common ore minerals; determination of elemental composition of minerals and rocks by flame photometer and atomic absorption spectrometer; preparation of thin sections and polished sections; etching and staining.

### **RECOMMENDED BOOKS**

1. Craig and Vaughan (1981): - Ore Petrography and Mineralogy
2. Evans (1993): - Ore Geology and Industrial Minerals
3. Sawkins (1984): - Metal Deposits in Relation to Plate Tectonics
4. Klemm and Schneider (1977): - Time and Strata- bound Deposits
5. A.M. Evans (1987): - An introduction to ore geology
6. Park and Mac Diarmid (1975): - Ore deposits

## SEMESTER III

### THEORY PAPER IX- HYDROGEOLOGY

**MARKS- 50**

**PERIODS- 40**

#### UNIT I

Ground water, origin, types, importance, occurrence, reservoirs and movement; renewable and non-renewable groundwater resources; hydrologic properties of rocks: porosity; permeability; specific yield; specific retention, hydraulic conductivity, transmissivity, storage coefficient

(8 Periods)

#### UNIT II

Groundwater quality, estimation of parameters, groundwater quality map of India; hydrographs; water table contour maps; hydrostratigraphic units,

(8 Periods)

#### UNIT III

Well hydraulics: confined, unconfined, steady, unsteady and radial flow; water level fluctuations; causative factors and their measurements; methods of pumping test and analysis of test data; evaluation of aquifer parameters

(8 Periods)

#### UNIT IV

Methods of artificial groundwater recharge; method of rainwater harvesting, problem of over exploitation of groundwater; groundwater legislation; water management in rural and urban areas, salt water intrusion in coastal aquifers; remedial measures.

(8 Periods)

#### UNIT V

Surface and sub surface geophysical and geological methods of groundwater exploration; hydrogeomorphic mapping using various Remote Sensing techniques; radioisotopes in hydrogeological studies, concept of watershed management, ground water management technical and social aspects.

(8 Periods)

### PRACTICAL PAPER IX- HYDROLOGY

**MARKS – 25**

**Total 6 Periods/ week**

Delineation of hydrological balance on water – table contour maps and estimation of permeability; analysis of hydrographs; geophysical and geological methods of ground water exploration; pumping test; time draw down and time recovery tests and evaluation of aquifer parameters; step drawdown tests; estimation of TDS using resistivity and SP logs; electric resistivity sounding for delineation of fresh and saline aquifers

#### BOOKS RECOMMENDED

- 1.Todd, D.K. (1980): -Groundwater Hydrology
- 2.Davies, S.N and De Wiest, R.J.M (1966): - Hydrogeology
- 3.Freeze, R.A. and Cherry, J.A. (1971): -Groundwater
- 4.Fetter, C.W. (1990): -Applied Hydrology
- 5.Raghunath, N.M. (1982): -Groundwater
- 6.Karanth, K.R. (1987): - Groundwater assessment, Development and Management
- 7.Alley, W.M. (1983): -Regional groundwater quality
- 8.Subramaniam, V.(2000) :-Water

## **THEORY PAPER X – FUEL GEOLOGY**

**MARKS –50**

**PERIODS- 40**

### **UNIT I**

Petroleum- its composition and different fractions; origin, nature and migration (primary and secondary) Of oil and gas; transformation of organic matter into kerogene; surface and subsurface occurrence of petroleum and gas.

(8 Periods)

### **UNIT II**

Characteristics of reservoir rocks and traps (structural, stratigraphic and correlation); Prospecting for oil and gas, drilling and logging procedures; oil-bearing basins of India; geology of the productive oil fields of India; position of oil and natural gas in India; future prospects and the economic scenario.

(8 Periods)

### **UNIT III**

Coal- Definition and origin of kerogen and coal; sedimentology of coal bearing strata; rank, grade and type of coal; Indian and International classifications of coal; macroscopic ingredients and microscopic constituents; concept of maceral and microlithotypes.

(8 Periods)

### **UNIT IV**

Chemical characterization: proximate and ultimate analysis; coal petrology and its application in solving industrial and geological problems; preparation of coal for industrial purposes; coal carbonization (coke manufacture) coal gasification and coal hydrogenation  
Coal bed – methane: a new energy resource. Hydrocarbon evaluation,

(8 Periods)

### **UNIT V**

Atomic fuel- Mode of occurrence and methods of prospecting and productive geological horizons in India; nuclear power stations of the country and future prospects; mud engineering, drilling fluid, gas sampling, mud logging , sample catching and its examination and interpretation

(8 Periods)

## **PRACTICAL PAPER X- FUEL GEOLOGY**

**MARKS –25**

**Total 6 Periods/ week**

Megascopic characterization of banded coals; proximate analysis of coals; completion of outcrops in the given maps and calculation of coal reserves; microscopic examination of polished coal pellets (identification of macerals in coal)Megascopic and microscopic study of cores and well cuttings; study of geological maps and sections of important oilfields of India; calculation of reserves

### **BOOKS RECOMMENDED**

- 1.Taylour, G.H., Teichmuiler, M., Davis, A., Diessel, C.F.K. and others: - Organic Petrology
- 2.Selley, R.C.: -Elements of Petroleum Geology
- 3.Chandra, D., Singh, R.M and Singh, M.P.: -Textbook of Coal
- 4.Singh, M.P.: - Coal and Organic Petrology
- 5.Stach, E, Macknowsty, M.T.H; Taylor, H.H and others: - Stach’s Textbook of Coal Petrology
- 6.Durrance, E.M.: -Radioactivity in Geology: Principles and Applications

## **THEORY PAPER XI- GEOPHYSICAL EXPLORATION**

**MARKS- 50**

**PERIODS- 40**

### **UNIT I**

Variation of gravity over the surface of the earth; principles of gravimeters; gravity field surveys; various types of corrections applied to gravity data; preparation of gravity anomaly maps and their interpretation in terms of shape, size and depth.

(8 Periods)

### **UNIT II**

Geomagnetic field of the earth; magnetic properties of rocks; working principles of magnetometers; field surveys and data reductions; quantitative interpretation; magnetic anomalies due to single pole, dipole; introduction to aeromagnetic surveys

(8 Periods)

### **UNIT III**

Resistivity methods; basic principles; various types of electrode configurations; field procedure profiling and sounding.

(8 Periods)

### **UNIT IV**

Seismic methods; fundamental principles of wave propagation; refraction and refraction surveys; concept of seismic channels and multi- channel recording of seismic data; End- on and split spread shooting techniques; CDP method of data acquisition; sorting; gather; stacking and record section; seismic velocity and interpretation of seismic data

(8 Periods)

### **UNIT V**

Application in mineral and petroleum exploration; description of bore- hole environment; brief outline of various well- logging techniques; principles of electrical logging and its application in petroleum; groundwater and mineral exploration; prospecting for radioactive minerals.

(8 Periods)

## **PRACTICAL PAPER XI- GEOPHYSICAL EXPLORATION**

**MARKS –25**

**Total 6 Periods/ week**

Interpretation of geophysical logs for geological purpose; application of geophysical data in mineral exploration- gravity data, magnetic data, electrical data; utility of seismic reflection data in recognition of subsurface structures; interpretation of seismic data.

### **BOOKS RECOMMENDED**

- 1.Sharma, P.V. (1986): -Geophysical Methods in Geology
- 2.Dobrin, M.B. (1976) :-Introduction to Geophysical Prospecting
- 3.Paransis, D.S. (1975): -Principles of Applied Geophysics
- 4.Stanislave, M. (1984) :-Introduction to Applied Geophysics
5. Rao, M.B.R. :-Outlines of Geophysical Prospecting Manual for Geologists

## **THEORY PAPER XII- ENVIRONMENTAL GEOLOGY**

**MARKS –50**

**PERIODS- 40**

### **UNIT I**

Introduction, Environmental dilemmas, fundamental concepts of environmental geology. Environmental protection – legislative measures in India (8Periods)

### **UNIT II**

Concept of green house gases, emission of Co<sub>2</sub>, consequences of green house gases, control and remedial measures, global warming and its impact on environment. (8Periods)

### **UNIT III**

The concept of earth system cycles in earth system- The energy cycle (energy inputs, solar radiations, geothermal energy, tidal –energy). The rock cycles (heat transfer in earth, plate tectonics and earth's external structure).

### **UNIT IV**

Assessing geological hazards and risks, types of hazards earth quakes, volcanic eruptions, floods, subsidence, landslides- preventive and precautionary measures. Environmental impacts of mining, surface blasting etc. Impact assessment of mining; dumping of ores; mine waste and fly ash (8Periods)

### **UNIT V**

Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization; organic and inorganic contamination of groundwater and its remedial measures; water logging problems. Soil profiles and soil quality degradation (8Periods)

## **PRACTICAL PAPER XII- ENVIRONMENTAL GEOLOGY**

**MARKS –25**

**Total 6 Periods/ week**

Study of seismic and flood prone in India; hydrochemistry analysis surface water and subsurface water; classification of groundwater for use in drinking, irrigation and industrial purposes; presentation of chemical analysis; data and plotting; chemical classification diagram; evaluation of environmental impact of air pollution and groundwater pollution; deforestation; landslides.

### **BOOKS RECOMMENDED**

- 1.Keller, E.A.: - Environmental Geology
- 2.Buyant, E.: -Natural Hazards
- 3.Valdiya, K.S.: -Environmental Geology- Indian Context
- 4.Patwardhan, A.M.: -The Dynamic Earth System
- 5.Bell, F.G.: -Geological Hazards
- 6.Smith, K.: -Environmental Hazards
- 7.Subramaniam, V.: -Textbook in Environmental Hazards
- 8.Tank, R.W.: -Focus on Environmental Hazards
- 9.Strahler and Strahler: -Environmental Geology
- 10.Trunk and Trunk: -Environmental Geology

## SEMESTER – IV

### THEORY PAPER XIII- MINING GEOLOGY

**MARKS –50**

**PERIODS- 40**

#### UNIT I

Intersecting loci and ring targets; guides to ore localization.

(8 Periods)

#### UNIT II

Subsidence and the support of mine excavation; timber treatment; methods of breaking rocks; drilling blast holes; explosives used in mining; blasting practices; shaft sinking; mine drainage; ventilation; illumination

( 8 Periods)

#### UNIT III

Alluvial, open- pit and under ground mining methods; drifting; cross cutting; winzing; stoping; room and pillaring; top –slicing; sub- level caving and block caving; ocean bottom mining, mine organization and operation; mine hazards.

( 8 Periods)

#### UNIT IV

Factors in evaluating a mineral deposit; mine examination; theory and methods of sampling; sampling calculations; recoverable values

( 8 Periods)

#### UNIT V

Cost of mining; future costs and profits; life of mine; present value of mine and its determination by compound interest and Hoskold formula methods; amortisation; calculations pertaining to valuation of mines of uniform and non uniform annual income; sale of mineral products; metal prices and mine valuation; valuation of prospects: developed mines and working mines; valuation report.

( 8 Periods)

### PRACTICAL PAPER XIII- MINING GEOLOGY

**MARKS- 25**

**Total 6 Periods/ week**

Determination and evaluation of ores in mines; different sampling calculations; recoverable values; cost of mining; future cost and profits; life of mine; determination of present value of mines; cross section of mines with the help of available data.

#### BOOKS RECOMMENDED

- 1.Young, G.J.: - Elements of Mining
- 2.Lewis, R.A. and Clark, G.A. :- Elements of Mining
- 3.Arogyaswami : - Mining Geology
- 4.ckinstry, H.E.: - Mining Geology
- 5.Sheryanthov, L.: - Mining of Mineral deposits

## THEORY PAPER XIV- GEOCHEMISTRY

MARKS – 50

PERIODS- 40

### UNIT I

Introduction of Geochemistry and Cosmochemistry. Chemical composition and properties of Earth's layers. Atmosphere: its layers, chemical composition and evolution of Atmosphere. Meteorites. Gold-Schmidt geochemical classification. (8 Periods)

### UNIT II

Isotope geochemistry; kinds of isotopes; Radiogenic isotopes. Decay scheme of K-Ar, U-Pb, V-Pb, Sm-Nd and Rb-Sr; Radioactive dating of single minerals and whole rocks; Stable isotope geochemistry of Carbon and Oxygen and its application in Geology. Geochemistry of Uranium and Lithium. (8 Periods)

### UNIT III

Concept of enthalpy, free energy; chemical potential; fugacity, Structure and types of atoms. Internal structure of atoms, atomic weights. Types of chemical bonding. Ionic radii. Coordination number. Lattice energy. Ionization potential. Electronegativity. Pauling's rule. Isomorphism and polymorphism. Principles of ionic substitution in minerals. (8 Periods)

### UNIT IV

Eh and pH diagrams, limits of Eh and pH in nature;; oxidation and reduction in sedimentation. Geochemical cycle; Minor cycle and Major cycle. Geochemical classification of elements. distribution of elements in igneous, metamorphic and sedimentary rocks. Periodic table with special reference to rare earth elements and transition elements. (8 Periods)

### UNIT V

Concept of geochemical- biogeochemical cycling and global climate; Hydrosphere: the hydrological cycle, composition of natural waters, some characteristics of river waters and ground water; Biosphere: Introduction: the mass of the biosphere: composition of the biosphere: biogenic deposits; geochemical cycle of carbon. (8 Periods)

## PRACTICAL PAPER XIV- GEOCHEMISTRY

MARKS 25

Total 6 Periods/ week

Preparation and interpretation of geochemical maps; Rock/ sediments/ water/ soil analysis; Preparation of classificatory and variation diagrams, REE normalized plots and their interpretation

### BOOKS RECOMMENDED

1. Mason, B. and Moore, and C.B.: - Introduction to Geochemistry
2. Faure, G.: -Principles of Isotope Geology
3. Hoefs, J.: -Stable Isotope Geochemistry
4. Marshal, C.P. and Fairbridge, R.W.: -Encyclopedia of Geochemistry
5. Govett, G. J.S.: -Handbook of Exploration Geochemistry
6. Kraustopf, K.B.: - Introduction to Geochemistry

## **THEORY PAPER XV- ENGINEERING GEOLOGY**

**MARKS- 50**

**PERIODS-40**

### **UNIT I**

Role of engineering geology in civil construction; engineering properties of rocks and soils; rock discontinuities; building stones; metal and concrete aggregates as construction material; use of aerial photography, groundwater investigation; subsurface exploration

(8 Periods)

### **UNIT II**

Geological consideration for evaluation of dams and reservoirs sites; classification of dams; dam foundation problems; reservoir problems

(8 Periods)

### **UNIT III**

Geotechnical evaluation of tunnels; classification of tunnels; methods of tunneling and tunnel design; support in tunneling; roads, bridges and bridge foundation; airfields, highways.

(8 Periods)

### **UNIT IV**

Mass movements; landslides; stability of slopes; causes of slides; creep movement; earth flow and subsidence - precautionary measures and mitigations of hazards

(8 Periods)

### **UNIT V**

Earthquake and seismicity; seismic zones of India; aseismic design of building; engineering problems related to precautionary measures and mitigations of hazards; beach engineering.

(8 Periods)

## **PRACTICAL PAPER XV- ENGINEERING GEOLOGY**

**MARKS 25**

**Total 6 Periods/ week**

Suitable dam sites, selection for sites of tunnels; seismic zones in India; compressional strength, tensile strength of rock and building materials; hardness test; roughness test; magnetic, seismic and electrical resistivity methods of exploration as applied to engineering investigations; interpretation of drilling data for engineering construction.

### **BOOKS RECOMMENDED**

- 1.Krynine and Judd: - Principles of Engineering Geology
- 2.Richeny, J.E.: - Elements of Engineering Geology
- 3.Lagget: - Geology and Engineering
- 4.Trefethen, Joseph- Geology of Engineers
- 5.Gupte, R: -Textbook of Engineering Geology

## **THEORY PAPER XVI- STATISTICAL GEOLOGY AND COMPUTER APPLICATIONS IN GEOLOGY**

**MARKS- 50**

**PERIODS- 40**

### **UNIT I**

Statistical methods; mean; median and mode; standard deviation; skewness and kurtosis and their interrelationship; scatter diagrams; frequency distribution; histogram; coefficient of correlation and regression

(8 Periods)

### **UNIT II**

Nature of geological data; scales of measurement; concepts and types of models in geology; sample population; population distribution and population density function and their properties

(8 Periods)

### **UNIT III**

Distribution of sample variance and chi square distribution; probability; testing normal distribution; students 't' test, 'f' test; confidence interval, analysis; calculation of variance- covariance, simple linear models; cluster analysis

(8 Periods)

### **UNIT IX**

Information systems; general – purpose applications; input- output devices; operating systems; memory; microprocessor; ports; utilities; secondary storage.

(8 Periods)

### **UNIT V**

Computer application to petrological and geochemical problems; use of standard software analysis and interpretation of geological data; writing of simple programs to apply some elementary statistical techniques to geological data; GIS-vector and raster data, GIS application in interpretation of geological data.

(8 Periods)

## **PRACTICAL PAPER XVI- STATISTICAL GEOLOGY AND COMPUTER APPLICATIONS IN GEOLOGY**

**MARKS 25**

**Total 6 Periods/ week**

Interpretation of histograms, cumulative curves, scatter diagrams; problems on the student 't' test, chi square test. mean; median and mode; standard deviation; skewness and kurtosis and their interrelationship. Application of computer to petrological and geochemical problems

### **BOOKS RECOMMENDED**

- 1.J.C.Davis: - Statistics and data analysis in Geology
- 2.B.L.Raktoe and J.J. Hubert: - Basic applied Statistics
- 3.P.Mukhopadhyaya: - Mathematical Statistics
- 4.H.E. Klugh: - Statistics- the essential for research

5.E.B. Mode: - Elements of statistics