# Department of Earth Sciences

**Course structure, Marks Scheme**

**& Syllabi**

**for**

**M. Sc. – Applied Geology**

**2-year course**
**(Semester System)**

**Effective from**

**Academic Session 2011**

# University of Kashmir

# Srinagar- 190 006

# Course Structure & Marks Scheme

## First Semester

| Course No. | Subject | Marks | | |
|---|---|---|---|---|
| | | Total | Continuous Assessment* | Exam¥ |
| **Theory** | | | | |
| GL-T1 | Structural Geology and Global Tectonics | 100 | 20 | 80 |
| GL-T2 | Paleobiology & Stratigraphy | 100 | 20 | 80 |
| GL-T3 | Mineralogy & Crystallography | 100 | 20 | 80 |
| GL-T4 | Geochemistry | 100 | 20 | 80 |
| **Practical** | | | | |
| GL-P1 | Structural Geology | 50 | 10 | 40 |
| GL-P2 | Paleobiology & Stratigraphy | 50 | 10 | 40 |
| GL-P3 | Mineralogy, Crystallography & Geochemistry | 50 | 10 | 40 |
| | **Total marks for semester-I** | **550** | **110** | **440** |

Geological Field Training for 1 to 2 weeks is to be conducted within the state to be examined at the end of second semester. (see below)

## Second Semester

| Course No. | Subject | Marks | | |
|---|---|---|---|---|
| | | Total | Continuous Assessment* | Exam¥ |
| **Theory** | | | | |
| GL-T5 | Igneous Petrology | 100 | 20 | 80 |
| GL-T6 | Metamorphic Petrology | 100 | 20 | 80 |
| GL-T7 | Sedimentology | 100 | 20 | 80 |
| GL-T8 | Ore, Fuel & Exploration Geology | 100 | 20 | 80 |
| **Practical** | | | | |
| GL-P4 | Igneous & Metamorphic Petrology | 50 | 10 | 40 |
| GL-P5 | Sedimentology | 50 | 10 | 40 |
| GL-P6 | Ore, Fuel & Exploration Geology | 50 | 10 | 40 |
| **Field Training** | | | | |
| GL-FT | Geological Field Training for 4 to 5 weeks is to be conducted outside the state. | 250 | 50 | 200 |
| | **Total marks for semester-II** | **800** | **160** | **640** |

## Third Semester

| Course No. | Subject | Marks | | |
|---|---|---|---|---|
| | | Total | Continuous Assessment* | Exam[¥] |
| **Theory** | | | | |
| GL-T9 | Tectonic Geomorphology | 100 | 20 | 80 |
| GL-T10 | Hydrogeology | 100 | 20 | 80 |
| GL-T11 | Remote Sensing & GIS | 100 | 20 | 80 |
| GL-T12 | Engineering & Environmental Geology | 100 | 20 | 80 |
| **Practical** | | | | |
| GL-P7 | Hydrogeology | 50 | 10 | 40 |
| GL-P8 | Remote Sensing & GIS | 50 | 10 | 40 |
| GL-P9 | Engineering & Environmental Geology | 50 | 10 | 40 |
| | **Total marks for semester-III** | **550** | **110** | **440** |

## Fourth Semester

| Course No. | Subject | Marks | | |
|---|---|---|---|---|
| | | Total | Continuous Assessment* | Exam[¥] |
| **Theory** | | | | |
| GL-T13 | Special Paper[@] | 100 | 20 | 80 |
| **Project Work Dissertation** | | | | |
| GL-D | Project work dissertation on any topic to be decided by the Department[$] | | | |
| | (i). Dessertation write-up | 200 | 40 | 160 |
| | (ii). Dessertation viva-voce | 100 | 20 | 80 |
| | | 300 | 60 | 240 |
| **Grand viva-voc** | | | | |
| | Grand viva-voce[#] covering the syllabus of first three semesters. | 100 | 20 | 80 |
| | **Total marks for semester-IV** | **500** | **100** | **400** |

**Note:**

* Marks to be awarded by teacher(s) concerned.

[¥] Marks to be awarded by the external examiner.

[@] Options for GL-T13 Special Paper:

| | | | |
|---|---|---|---|
| GL-T13-A | Rock Deformation and Structural Analysis | GL-T13-D | Advance Remote Sensing in Geosciences |
| GL-T13-B | Sedimentary Environment and Sedimentary Basins | GL-T13-E | Oceanography and Marine Geology |
| GL-T13-C | Advanced Hydrogeology | GL-T13-F | Petroleum Exploration |

[$] Project work to be assigned individually to the student.

[#] Viva-voce to be conducted by the external examiner along with whole faculty.

# Summary of Courses and Marks

| Total no. of Courses | | | Marks | | |
|---|---|---|---|---|---|
| | | | **Total** | **Continuous Assessment** | **Exam** |
| **First Semester** | Theory | 4 | 400 | 80 | 320 |
| | Practical | 3 | 150 | 30 | 120 |
| **Second Semester** | Theory | 4 | 400 | 80 | 320 |
| | Practical | 3 | 150 | 30 | 120 |
| | Geological Field Training | 1 | 250 | 50 | 200 |
| **Third Semester** | Theory | 4 | 400 | 80 | 320 |
| | Practical | 3 | 150 | 30 | 120 |
| **Fourth Semester** | Theory | 1 | 100 | 20 | 80 |
| | Project work | 1 | 300 | 60 | 240 |
| | Grand viva-voce | 1 | 100 | 20 | 80 |
| **Total** | | | **2400** | **480** | **1920** |

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Detailed syllabi follows next.

# Syllabi

## Instructions for paper setters of M. Sc. (Applied Geology) Course

**Paper setter is requested to follow the below mentioned instructions while setting the question papers.**

1. The duration of examination of each theory paper is **two and half-hours** with **80** marks, unless otherwise mentioned.

2. The question paper should comprise of three sections: **A**, **B** and **C.**

   Section **A** should comprise of **Very Short Answer** questions,
   Section **B** should comprise of **Short Answer** questions,
   Section **C** should comprise of **Long Answer** questions.

3. Student will have to attempt all question from Section **A** and **B** and only two questions from Section **C.**

4. Section **A** will have **8 questions** with **2 marks** for each question, covering all the four units in the paper. Students are expected to answer each question in **10-20 words**

5. Section **B** will have **4 questions** with **8 marks** for each question, covering all the units in the paper. Students are expected to answer each question in **200-250 words**

6. Section **C** will have **4 questions** with **16 marks** for each question, covering all the four units in the paper. Students are expected to answer each question in **400-500 words**

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# First Semester

## THEORY

### GL-T1 Structural Geology and Global Tectonics

| Unit | Course content |
|---|---|
| 1. | Introduction: Mechanical principles and properties of rocks and their controlling factors. Theory of Rock failure.<br>Concept of stress and strain: Two dimensional analyses of stress and strain. Types of strains ellipses and ellipsoids, their properties and geological significance. |
| 2. | Fold: Mechanics of folding and buckling. Fold development and distribution of strain in folds.<br>Fractures and joints: Their nomenclature, age relationship, origin and significance. Causes and dynamics of faulting, strike-slip faults, normal faults, over thrust and nappe. |
| 3. | Concept of petrofabrics and symmetry: Planer and linear fabrics in deformed rocks, their origin and significance. Objective field and laboratory techniques, graphic treatment, types of fabrics, fabric elements and interpretation of fabric data on microscopic and mesoscopic scale. Significance and limitations of π- and β-diagrams. Geometrical analysis of simple and complex structures on macroscopic scale. |
| 4. | Global tectonics: Physiographic and crustal types. Seismic, density, thermal and chemical characters of the crust, mantle and core. Plate tectonics as a geodynamic model. Plate tectonics and mountain building. Models of mountain building – Pacific and Andean-types orogenies. Collision tectonics. Some basic data sets unexplained by Plate tectonics. Surge tecotonics as an alternative geodynamic model. |

### Books recommended:


Condie, K. C., 1976: *Plate tectonics and crustal evolution. Pergamon.*
Cox, A., 1996: *Plate Tectonics.* Blackwell.
Davis, G. R., 1984: *Structural Geology* of *Rocks and Region.* John Wiley.
Ghosh. S. K., 1995: *Structural Geology Fundamentals* of *modem Developments.* Pergamon Press.
Hobbs, B. E., Means, W. D. and Williams, P. F., 1976: *An Outline* of *Structural Geology.* John Wiley.
Kearey, P. and Vine, 2000: *Global Tectonics.* Black Well.
Meyerhoff et aI., 1996: *Surge Tectonics,* Kluwer Pub.
Price, N. J. and Cosgrove, J. W., 1990: *Analysis* of *Geological Structure.* Cambridge Univ. press.
Ramsay, J. G, 1967: *Folding and Fracturing* of *Rocks.* McGraw Hill.
Ramsay, J. G. and Huber, M. I., 1987: *Modem Structural Geology,* Vol. I & II. Academic Press.


### GL-T2 Paleobiology and Stratigraphy

| Unit | Course content |
|---|---|
| 1. | General aspects of paleobiology: Modern concepts of origin of life. Precambrian fossil record and Origin of Metazoa. Taphonomy and Fossil communities. Methods and techniques in Paleontology, Introduction to Molecular Paleontology.<br>Invertebrate paleontology: Morphology and evolutionary trends in Ammonoids, Brachiopods, Graptolites and Trilobites. |
| 2. | Micropaleontology: Introduction to various groups of microfossils, their importance in geology; Morphology, classification and evolutionary trends of Foraminifera, Ostracodes and Conodonts, their ecological and geological significance.<br>Paleobotany: An account of important Gondwana fossils of India with respect to paleoclimatic conditions. Introduction to palynology and its applications; brief morphology of spores and pollens. Paleno - facies application to Hydrocabon exploration |
| 3. | Vertebrate paleontology: Scope and application of Vertebrate Paleontology; Landmarks in Vertebrate evolution. Siwalik mammals, Phylogeny of Equidae and Proboscidae. |
| 4. | Stratigraphy: Basic principles of stratigraphy, Concept of stratigraphic Facies, Stratigraphic correlation, Graphic representation of stratigraphic data. Outline idea about Seismic Stratigraphy, Magnetostratigraphy,<br>Boundary problems: Boundary problems in stratigraphy with reference to Precambrian - Cambrian, Permian -Triassic, Cretaceous - Tertiary and Pliocene - Pleistocene boundaries.<br>Study of paleogegraphy, plaeoclimate and igneous and mountain building activities in the Indian subcontinent from Late Cretaceous. |

**Books recommended:**


Arnold, C. A., 1947: An introduction to Paleobotany. Mc Graw - Hill Book Co.
Bignot, G., 1985: *Elements of Micropaleontology*. Graham and Trotman.
Brasier, M. D., 1980: *Microfossils.* George Allen & Unwin.
Clerkson, E. N. K., 1998: *Invertebrate Paleontology and evolution.* Black Well
Colbert, E. H, 1955: *Evolution of Vertibrate.* Jhon Wiley& sons, London.
Dunbar, C. O, Rodger, J., 1957: *Principles of stratigraphy.* Wiley International.
Glassner, M. F., 1945: *Principles of Micropaleontology.* Hafner Pub.
Krishanan, M. S., 1968: *Geology of India and Burma.* Higginbothams Pvt. Ltd., Madras.
Kumar, R, 1998: *Fundamentals of Historical Geology and Stratigraphy.* Wiley Eastern Limited.
Shork & Twenholf, 1987: *Principles of invertibrate Paleontology.* CBS Pub., N. Delhi.
Wadia, D. N., 1957: *Geology of India.* Mcmillan, London.
Weller, J. M., 1960: *Stratigraphy Principles* & *Practice.* Harper & Row Pub.
Wood, H., 1968: Paleontology invertebrate. CBS Pub., N. Delhi.


## GL-T3 Mineralogy and Crytallography

| Unit | Course content |
|---|---|
| 1. | Elements of Crystallography: External & Internal symmetry in crystals; Symmetry elements; Improper axis; Combination of symmetry elements. |
| 2. | Crystal Systems: 32 classes of crystals, spherical and stereographic projections. |
| 3. | Optical Mineralogy: Concept and application of optical indicatrix. Interference phenomenon. Orthoscopic and conoscopic study of minerals. Optic figure, optic sign, dispersion, pleochroism and absorption.<br>Determinative methods in mineralogy: Refractive index (colored Backeline variation methods), Pleochroism scheme and 2V Microscopic methods, Axiality and optic sign. |
| 4. | Systematic mineralogy: Atomic structure, mineral chemistry and their PT-stability and mode of occurrence of silicates, native elements, sulphides, oxides, hydroxides and carbonates. Mineral assemblages. |

**Books recommended:**


Berry & Mason, 1988: *Mineralogy.* CBS Pub.
Hutchinson, C. S., 1974: *Laboratory Handbook of Petrographic Techniques.* John Wiley.
Kerr, P. F., 1977: *Optical Mineralogy.* McGraw Hill.
Kerr, P. F., 1977: *Optical Mineralogy.* McGraw Hill.
Nesse, 1987: *Optical Mineralogy*.
Phillips, Wm, R. and Griffen, D.T., 1986: *Optical Mineralogy.* CBS Edition.
Putnis, A., 2001: *Introduction to mineral Science.* Cambridge University Press.
Putnis, A., 1992: *Introduction to mineral Science*. Cambridge University Press.
Richard, V. G., 1997: *Dana's new Mineralogy*. John Wiley.
Spear, F. S. 1993: *Mineralogical Phase Equilibria and Pressure-Temperature Paths.* Mineralogical Society of America Pub.
Read, H. H.,1986: *Rutleys Elements of Mineralogy*.
Winchell, A. N., 1968: *Elements of optical mineralogy.* Wiley Eastern Pvt Ltd.
Winchell, A. W., 1937: *Elements of Optical Mineralogy* ( Principles & Methods). John Wiley Pvt Ltd.


## GL-T4 Geochemistry

| Unit | Course content |
|---|---|
| 1. | Introduction to geochemistry: Properties associated with bond type: ionic properties, radius ratio, co-ordination principle, Pauling's rule, ionic substitution and crystalline solutions. Polymorphism and pseudomorphism; Exsolution, Non-crystalline minerals (mineraloids). Geochemical classification of elements. |
| 2. | Major, Trace & Rare Earth Element (REE) Geochemistry: Concepts of partitioning and distribution coefficients of trace elements between solid and liquid phases vis-à-vis partial melting and magma generation. Distribution of REE in earth's mantle and crust. |
| 3. | Isotope geochemistry: Decay mechanism and growth of isotopes. Geochronological applications of Rb-Sr, K-Ar, U-Th-Pb and Sm-Nd systematics. |
| 4. | Stable isotope geochemistry (oxygen, hydrogen, carbon & sulphur): nature, abundance, fractionation and applications. |

**Books recommended:**


Attendron, H. G., 1997: *Radioactive and Stable Isotopes Geology*. Pergamon Press.
Cox, P. A., 1995: *Elements of Earth.* Oxford Univ. Press.
Faure, G., 1986: *Principles of Isotope Geology.* John Wiley.
Garrels & Christ, 1966: *Solution Minerals and Equalibria*. Pergamon Press.
Gunter, F., *Principles and Applications of inorganic Geochemistry*.
Henderson, P., 1987: *Inorganic Geochemistry.* Pergamon Press.
Hoefs, J., 1980: *Stable Isotope Geochemistry.* Springer Verlag.
Krauskopf, K. B., 1967: *Introduction to Geochemistry.* McGraw Hill.
Marshal, C. P. and Fairbridge, R. W., 1999: *Encyclopedia of Geochemistry*. Kluwer Academic.
Mason, B. and Moore, C. B., 1991: *Introduction to Geochemistry.* Wiley Eastern.
Nordstrom, D. K. and Munoz, J. L., 1986: *Geochemical Thermodynamics*. Blackwell.
Raid, C. E., *Chemical Thermodynamics*. Chapman & Hall.


## PRACTICAL

### GL-P1 Structural Geology

Structural Geology: Preparation and interpretation of geological maps and sections. Structural problems concerning economic mineral deposits. Exercises for determination of finite strain. Exercises for fold analysis by π- and β-diagrams. Plotting and interpretation of petro-fabric data and resultant diagrams. 3 to 4 exercises of structural analysis.

### GL-P2 Paleobiology & Stratigraphy

Paleobiology & Startigraphy: Study of selected invertebrate fossils illustrating their morphology. Taxonomic study of selected Gondwana plant fossils. Study of selected important rocks & fossils from Indian stratigraphic horizons and preparation of statigraphic column.

### GL-P3 Mineralogy, Crystalography and Geochemistry

Mineralogy & Crystallography: Drawing of crystallographic projections; Identification of some important rock forming minerals in hand specimens and thin sections. Exercises in mineral optics. Exercises on thin section and polished section making, etching and staining.

Geochemistry: Depending upon analytical facilities, exercises in rock/sediment sample dissolution and determination of their elemental composition. Calculation CIPW norms, preparation of variation diagrams. Calculation of weathering indices in soil and sediments. Presentation of analytical data.

### GL-FT Geological field Training

Local Geological Field Training for 1 to 2 weeks is to be conducted with in the state.

## Second Semester

### GL-T5 Igneous Petrology

| Unit | Course content |
|---|---|
| 1. | Introduction to igneous petrology: Magma: nature, cooling behavior, properties and chemistry; volatiles in silicate melts, magmatic crystallization. |
| 2. | Rock associations and classification schemes of igneous rocks;<br>Phase equilibria: Unary, Binary and Ternary systems. |
| 3. | Genesis, source and tectonic setting of different Magma Types: Basaltic, granitic and alkaline magmas. |
| 4. | Application of major and trace elements (including REE) and Sr, - Pb, - and Nd - isotopes studies in deciphering magma generation, mantle - crust interactions and tectonic environments. |

**Books recommended:**


Albert, J., 1967: *Descriptive petrology of the Igneous Rocks*. Mc-Graw Hill, New York.
Alexander, Mc. B., 1987: *Igneous Petrology.* Prentice Hall.
Barth, T. F. W., 1956: *Theoretical Petrology*. Mc-Graw Hill, New York.
Best, M. G., 1986: *Igneous Petrology,* CBS Pub.
Bose, M. K., 1997: *Igneous Petrology*. World Press.
Hall, A., 1988: *Igneous petrology.* ELBSI Longman.
Harker, A., 1944: *Natural History of Igneous Rocks*. McMillan Press.
Hatch & Wells, *Text Book of Petrology*. CBS Pub.
McBirney, A. R., 1993: *Igneous Petrology*. John Wiley.
Philpotts, A., 1992: *Igneous and Metamorphic Petrology.* Prentice Hall.
Turner, F. J., 1960: *Igneous and Metamorphic Petrology*. Mc-Graw Hill, New York.
Turner & Verhoogen, 1999: *Igneous and Metamorphic Petrology.* CBS Pub.
Tyrrell, G. W., *Principles of Petrology.* CBS Pub.
Shand, S. J., 1977: *Eruptive Rocks.* Mc-Graw Hill, New York.
Shelley, D., 1995: *Descriptive Petrology of the Igneous Rocks.* Chapman & Hall.


## GL-T6 Metamorphic Petrology

| Unit | Course content |
|---|---|
| 1. | Introduction to metamorphic petrology: Metamorphism and metamorphic processes, factor controlling metamorphism, types of metamorphism, Metamorphic minerals, Index minerals, Metamorphic differentiation. |
| 2. | Metamorphic facies classification and systematic description of regional and thermal metamorphism of pelitic, basic-ultra-basic and impure calcareous rocks. |
| 3. | Metamorphic reactions: Basic characteristics of metamorphic reactions: solid-solid reactions, dehydration reactions, decarbonization and oxidation-reduction reactions and their implications to geothermo-barometry. Metasomatism and anataxis. |
| 4. | Regional metamorphism and paired metamorphic belts in reference to plate tectonics. P-T - Time paths. |

**Books recommended:**


Bucher, K. and Frey, M., 1994: *Petrogenesis of Metamorphic rocks.* Springer-Verlag.
Miyashiro, A., 1994: *Metamorphic Petrology.* UCL Press Ltd., London.
Philpotts, A., 1992: *Igneous and Metamorphic Petrology.* Prentice Hall.
Turner, F. J., 1960: *Igneous and Metamorphic Petrology*. Mc-Graw Hill, New York.
Turner, F. J., 1980: *Metamorehic Petrology.* McGraw Hill, New York. '
Turner & Verhoogen, 1999: *Igneous and Metamorphic Petrology.* CBS Pub.
Tyrrell, G. W., 1987: *Principles of Petrology.* CBS Pub
Yardley, B. W., 1989: *An Introduction to Metamorphic Petrology*. Longman, New York.


## GL-T7 Sedimentology

| Unit | Course content |
|---|---|
| 1. | Sedimentary processes: Introduction, Flow regimes.<br>Textures: Textural elements of clastic and non-clastic rocks; Size, roundness, sphericity, fabric, form and surface textures, their measurement, statistical treatment and interpretation; mass properties of rocks.<br>Sedimentary structures: Classification of sedimentary structures, their genesis and significance, Statistical treatment of plaeocurrent data. Use of textures and structures in sediment dispersal and basin studies. |
| 2. | Petrography: General classification of sediments. Sandstone – light and heavy minerals, their relationship with provenance. Carbonates – classification, environment of deposition. Mudstones – classification and identification.<br>Diagenesis: Diagenesis of mudstones, sandstones and carbonate rocks. |
| 3. | Sedimentary environments: Physical and chemical parameters of depositional environments. Classification of environments, Lithologies, Structures and Vertical sequences formed in alluvial, deltaic, coastal, and deep sea, and glacial and aeolian environments, field recognisation, micromorphological features and paleoclimatic significance.<br>Sedimentary facies: Concept and definition; Facies association; Walters Law of Facies and application. Sedimentary cycles and cyclothems. Facies models and environmental reconstruction. |

| | |
|---|---|
| 4. | Paleocurrents and plaeogeography: Cross bedding, Ripple marks, Sole marks in reconstruction of paleogeography; fabric and paleocurrent. Scaler properties and paleocurrents; Down current size decrease of clasts; roundness, shape and paleocurrents. Bed thickness, isopach and paleocurrents. Paleocurrent and time. Paleocurrent and basin analysis, and paleogeography.<br>Sedimentation and tectonics: Tectonic control on sedimentation, diastrophic cycle and sedimentation. Basin evolution in relation to plate tectonics. |

**Books recommended:**


Collinson, J. D, 1999: *Sedimentary Structures.* Springer Verlag.
Ehlers and Blatt, 1999: *Petrology, (Igneous, Sedimentary and Metamorphic).* CBS Pub.
Einsele, G., 1992: *Sedimentary Basins.* Springer Verlag.
Friedman, G. M. and Sander, J. E., 1978: *Principles of Sedimentology.* John Wiley.
Miall, A. D., 1999: *Principles of Sedimentary Basin Analysis.* Springer-Verlag.
Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: *Sand and Sandstone.* Springer Verlag.
Reading, J. G. 1996: *Sedimentary Environment and Facies.* Black well.
Reineck, H. E. and Singh, I.B., 1975: *Deposition Sedimentary Environment.* Spring-Verlag.
Selley, R. C., 1976: *Introduction of Sedimentology.* Academic Press, London.
Sengupta, S., 1997: *Introduction to Sedimentology.* Oxford-IBH.


## GL-T8 Ore, Fuel & Exploration Geology

| Unit | Course content |
|---|---|
| 1. | Ore Geology: Overview of space-time distribution of mineral deposits and global metallogeny. Synoptic view of the principal mechanisms of formation of the igneous, sedimentary and metamorphic mineral deposits. Weathering and Placer deposts. Ore deposits and plate tectonics. Mineral economics and its concept: National Mineral policy in relation to Strategic, critical and essential minerals. |
| 2. | Ore Microscopy: Physical and optical properties of ore minerals. Quantitative methods in ore microscopy – reflectivity and microindentation hardness, equipment and measurement techniques thereof. Microchemical studies of ore minerals: Determinative etching, structural etching, and tests for specific chemical elements. Fluid inclusions in ore: principles, assumptions, limitations and applications. |
| 3. | Fuel Geology: Origin and occurrence of petroleum, migration and accumulation of petroleum, reservoir rocks and traps, petroliferous basins of India. Macroscopic and microscopic constituents of coal. Geological and geographical distribution of coal deposits in India with emphasis on Gondwana coal fields of India. Mode of occurrence and association of atomic minerals in nature. Productive geological horizons in India. |
| 4. | Geochemical Prospecting: Concepts, dispersion, pathfinder elements, geochemical sampling, and geochemical field techniques<br>Geophysical prospecting: Basic principles, scope and application of geophysical prospecting. Principle, procedure, equipment used and applicability of gravimetric, magnetic, electrical, seismic and radiometric methods. Aerial geophysical surveys. |

**Books recommended:**


Arogyaswamy, R. N. P., 1987: Courses in Mining Geology. Oxford &IBH Pub. Co. Pvt. ltd.
Craig, J. M. & Vaughan, D. J., 1981: *Ore Petrography and Mineralogy.* John Wiley.
Chatterjee, K. K., 1993: *An Introduction to Mineral economics.* Wiley Eastern Ltd.
Dahlkamp, F. J., 1993: *Uranium Ore Deposits.* Springer Verlag.
Durrance, E. M., 1986: *Radioactivity in Geology. Principles and Application.* Ellis Hoorwool.
Evan, A. M., 1983: *Ore Geology and industrial Minerals.* Blackwell.
Holson, G. D. and Tiratsoo, E. N., 1985: *Introduction Petroleum Geology.* Gulf Pub. Houston,
Jensen, M. L. and Bateman, A. M., 1981: *Economic Mineral Deposits,* John Wiley.
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Prasad, U., 1996: *Economic Geology.* CBS Pub. N. Delhi.
Selley, R.C., 1998: *Elements of Petroleum Geology.* Academic Press.
Sinha, R. K. and Sharma, N. L. 1993: *Mineral Economics.* Oxford & IBH Pub. Co. Pvt. Ltd.
Stach, E. and Others, 1982: *Stach's Text Book of Coal Petrology.* Gebruder Borntraeger
Stanton, R. L, 1972: *Ore Petrology.* Mc-Graw Hill.
Tissot, B. P. and Welte, D. H, 1984: *Petroleum Formation and Occurrence.* Springer-Verlag.

## PRACTICAL

### GL-P4 Igneous & Metamorphic Petrology

Igneous & metamorphic: Megascopic and microscopic study of igneous lithotypes and metamorphic rocks of different facies. Modal analysis. Chemo-graphic diagram (ACF & AFM ternary diagrams)

### GL-P5 Sedimentology

Sedimentary Petrology: Megascopic and microscopic study of sandstones, limestones and heavy minerals. Paleocurrent analysis - collection of azimuthal data, graphical representation of data and determination of statistical parameters. Identification and study of feldspars and carbonate minerals (calcite, ferroan calcite, ferroan dolomite, aragonite & magnesite) by staining technique.

### GL-P6 Ore, Fuel & Exploration Geology

Ore & Fuel Petrology: Megascopic study of structures and fabric of different ores and their associations. Mineralogical and textural studies of common ore minerals under ore microscope. Exercises in the determination of reflectivity and microhardness of common ore minerals. Calculation of oil reserves. Megascopy and microscopy of coal samples. Completion of outcrops associated with coal geology. 3-points problems associated with borehole data.

### GL-FT Geological Field Training

Geological Field Training of 4 to 6 weeks to be conducted outside the state.

# Third Semester

## THEORY

### GL-T9 Tectonic Geomorphology

| Unit | Course content |
|---|---|
| 1. | Overview of geomorphology: Geomorphic processes and resulting landforms. Geomorphological cycle. Soils: Their development and classification.<br>Morphometric analysis of basins: Morphometric elements and parameter laws of drainage composition, drainage density, stream frequency, basin shape, hypsometry, relationship of morphometric parameters with discharge and sediment yield characters of basins. Morphometric evolution of Western Himalaya. |
| 2. | Introduction to Tectonic Geomorphology: Energetics, Active Tectonics & Models of landscape development. Controversies in tectonic geomorphology.<br>Geomorphic Markers: Planer and linear geomorphic markers, Marine Terraces, Beaches, Shorelines, lacustrine, Delta, River Terraces, Alluvial Fans, Lava flows, Debris flow, landslides. |
| 3. | Landform dating techniques: Relative – Clast seismic velocity method, Weathering rinds, Obsidian hydration rinds, Soil development and Carbonate coating method, Lichenometry; Absolute – Tree rings, Carbon dating, Luminescence dating.<br>Geomorphic Expression of Faults: Strike slip Faults, Normal Faults, Thrust Faults.<br>Palaeoseismology: Introduction and scope of Paleoseismology, Study of field techniques in Paleoseismology, Direct and indirect observations of paleoseismic displacements. Paleoseismic landforms, Use of liquefaction-induced features and landslides for Paleoseismic analysis. |
| 4. | Quaternary geomorphology: Cycles of climatic change (glacial and interglacial, pluvial and interpluvial) and their effect on landforms. Geomorphic sub-divisions of Indian subcontinent and their geomorphic features and evolution with special reference to Himalaya.<br>Landslides: Types, Causes and remedial measures. Graphical analysis of slope stability. Calculation of factor of stability. Stability of slopes, flow and creep, Settlement and subsidence, Slope modification and reinforcement. Instruments for monitoring slope movements. |

**Books recommended:**


Bloom, A. L., 2002: *Geomorphology, A Systematic Analysis of Late Cenozoic Land Forms.* Prentice Hall Pvt. Ltd., N. Delhi.
Burbank, D. W. and Anderson, R.S., 2001: *Tectonic Geomorphology* Blackwell Sciences Easterbrook, Easterbrook, 1994: *Surface Processes and Land Forms.* Prentice Hall.
McCalpin, J., 1996: *Paleoseismology* Academic Press.
Pitty, A. F, 1982: *Nature of Geo-Morphology.* University Paper Backs.
Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers, Lowa
Sharma, V. K., 1986: *Geomorphology*. Tata McGraw Hill.
Thorrenberry, W. D., 1997: *Principles of Geomorphology* New Age International, Delhi.
Vishwas, S. K and Gupta, A., 2001: *Introduction to Geomorphology* Orient Longman.


## GL-T10 Hydrogeology

| Unit | Course content |
|---|---|
| 1. | Introduction: Groundwater in the hydrologic cycle. Groundwater table - Groundwater table fluctuations and controlling factors. Subsurface inflow and outflow; Period of recharchage and discharge. Average groundwater fluctuations, effluent and influent streams.<br>Elementary theory of groundwater flow: Darcy's law and its range of validity. Steady and unsteady flow. |
| 2. | Hydrological properties of water-bearing materials: Porosity and permeability, transmissivity, storage coefficent, their definition and methods of determination. Water table maps and flow net analysis; differential equation for controlling groundwater flow.<br>Well hydraulics: Steady, unsteady and radial flow into a well. Confined and leaky confined and unconfined aquifers. Determination of aquifer characteristics from pump-tests. |
| 3. | Groundwater development: Groundwater exploration methods – geological & geophysical (resistivity, magnetic and seismic) methods. Borehole geophysical logging – electrical, resistivity and SP; Radiation logging – gama, gama-gama, and neutron logging. Cliper and temperature logging. Preparation of strata charts, design of tubewell assembly and water well design criteria. Water level development and yield tests, well completion reports. Groundwater modeling techniques, data requirement. |
| 4. | Groundwater basin management methods: Basic ideas of groundwater management. Water logging – causes and remedial measures; artificial recharge. Fresh and saltwater relationship in coastal areas.<br>Quality and geochemistry of water: Groundwater quality analysis – sampling methods, bacteriological, chemical and physical quality. Quality criteria for drinking, irrigation and industrial purposes. Pollution of groundwater. Groundwater and hydrochemical provinces of India. |

**Books recommended:**


Chow, V. T, 1988: *Advances in Hydrosciences,* McGraw Hill.
Freeze, R. A. & Cherry, J. A., 1979: *Ground Water*. Prentice Hall.
Fetter, C. W., 1990: *Applied Hydrogeology.* Merill Publishing.
Karanth, K. R., 1987: *Groundwater Assessment-Development and Management.* Tata McGraw Hill.
Todd, D. K.., 1980: *Groundwater Hydrogeology* John Wiley.
Raghunath, N. M., 1982: *Ground Water.* Wiley Eastern.
Ragunath, H. M., 1997: *Hydrology*, Principles, Analysis, Design. New Age Pub.


## GL-T11 Remote Sensing and GIS

| Unit | Course content |
|---|---|
| 1. | Remote sensing fundamentals, data sources, and image acquisition: History and scope of remote sensing, concepts of remote sensing, electromagnetic radiations, matter interactions with atmosphere and terrain, reflectance, absorptance and transmittance, spectral reflectance of vegetation, soils, minerals and rocks, scattering processes, basic elements of visual image interpretation, principles of image interpretation, verification and validation of RS data (Ground Truth). |
| 2. | Digital analysis of remote sensing data: Picture element and image statistics, Pre-processing of satellite data: geometrical corrections of satellite data, image enhancements, types of enhancements, filtering of images, digital image classification: Supervised and unsupervised classifications. Accuracy assessment: Sources of errors and measurement of map accuracy, kappa coefficient. |
| 3. | Remote sensing applications to geosciences: Earth sciences: Lithology and structure (faults, folds), Environmental: Land use and land cover changes, monitoring erosion, urbanization and deforestation. Survey: cadastral mapping, digital terrain models. Hydrology: application of remote sensing in hydrological modeling, ground water prospecting. |

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| 4. | Geoinformatics and its applications to earth sciences: Overview of GIS, Components of GIS, GIS software packages, Concept and types of information, integration of spatial and non spatial data, Data models: raster and vector data models, geospatial analysis for disaster management with case studies on landslides and floods, GIS for environmental applications like lake management and soil mapping. |

**Books recommended:**


Burrough, P.A., 2003: *Principles of Geographic Information* Systems. Oxford University Press.
Campbell, J., 2002: *Introduction to Remote Sensing.* Guilford Press, New York.
Demers, M. N., 1999: *Fundamentals of Geographic Information Systems.* John Wiley.
Jensen, J. R., 2004: *Remote Sensing of the Environment.* Prentice Hall, New Jersey.
John, A. Richards, 1993: *Remote Sensing Digital Image Analysis.* Springer-Verlag.
John, R. Jensen, 2000: *Introductory Digital Image Processing, A Remote Sensing Perspective.*
Lillesand, T. M. and Kiefer, R. W., 1987: *Remote Sensing in Geology.* John Wiley. Prentice Hall, New Jersey.
Lillesand, T. M. and Kiefer, R. W., 2002: *Remote Sensing and Image Interpretation,J.Wiley*
Rees, W. G., 2001: *Physical Principles of Remote sensing.* Cambridge University Press.
Sabbins, F. F., 1985: *Remote Sensing - Principles and Applications.* Freeman.


## GL-T12 Engineering & Environmental Geology

| Unit | Course content |
|---|---|
| 1. | Principles of engineering geology and geotectonics: Introduction, Engineering properties and classification of rocks. Factors affecting engineering services of rocks.<br>Engineering properties of soils. Soil liquefaction and creep. Stress distribution in soil and foundation failure. |
| 2. | Geological considerations for evaluation of dams, reservoir and tunnel sites: Dam foundation rock problems. Tunnel alignment and transportation routes. Methods of tunneling. Classification ground for tunneling purposes, various types of support.<br>Foundation evaluation techniques. Influence of geological conditions on foundation and design of buildings. |
| 3. | Environmental Geology: Introduction, Earth, man and environment – Basic environmental problems. Fundamental concepts of environmental geoscience. General relationship between landscape, climate and biomass. Geoscience factor in environmental planning. Earth processes and geological hazards with reference to floods, landslides, earthquakes and volcanism. |
| 4. | Cenozoic climate extremes, their impact on evolution of life especially on human evolution. Ice sheets and fluctuations in sea levels.<br>Health Geochemistry: Trace elements & radon emission. |

**Books recommended:**


Arms, K., 1990: *Environmental Science*. Saunders College Pub.
Bell, F. G., *Engineering Properties of Soils and Rocks.*
Bell, F. G., 1999: *Geological Hazards their assessment, Avoidance & Mitigation*. E&FN Spon London.
Bell, F. G., 1999: *Geological Hazards.* Routledge, London.
Bryant, E., 1985: *Natural Hazards.* Cambridge University Press.
Goodman, R. E., *Engineering Geology.*
Keller, E. A., 1978: *Environmental Geology.* Bell and Howell, USA.
Krynine, D. H. and Judd, W.R., 1998: *Principles of Engineering Geology*. CBS Pub.
Lanen, F., *Environmental Geology*.
Lawrence, L. *Environmental Geology*.
Lundgren, L, 1986, *Environmental Geology*. Prentice Hall.
Michael, A., *Basic of Environmental Science.*
Parasnis, D. S., 1975: *Principles of Applied Geophysics.* Chapman Hall.
Pipkin, B. W. & Trent, D. D., 1997: *Geology and the Environment*. West wardsworth.
Singh, A., *Modern Geo-Technical Engineering.*
Smith, K., 1992: *Environmental Hazards.* Rutledge, London.
Valdiya, K. S., 1987: *Environmental Geology -Indian Context.* Tata McGraw Hill.
Venkat, R. D., *Engineering Geology for Civil Engineers.*
Waltham, A. C., 1997: *Foundations of Engineering Geology*. Blackie Academic & Professional.

## PRACTICAL

### GL-P7 Hydrogeology

Hydrogeology: Delineation of hydrological boundaries on water-table contour maps and estimation of permeability. Preparation of isohytal maps, Theissen's polygonal method. Analysis of aquifer performance test data Thiem's, Theis's and Jacob's method. Design of water well screen and gravel pack on the basis of mechanical analysis data of aquifer material. Analysis of hydrographs and estimation of infiltration capacity. Study of geophysical well logs. Estimation of TDS using resistivity and SP logs. Plotting of groundwater provinces of India.

### GL-P8 Remote Sensing & GIS in Geology

Tutorial on different modules of image processing software; Import and export of satellite data; Different image and remote sensing data formats; Familiarization with the earth surface features on the images; Preparation of satellite data for analysis like rotate, reflect, subset, layer addition; Pre-processing of satellite data like image registration, geo-correction, filtering, image enhancements, math operations; Image ratios and other remote sensing and geological indices like SAVI; Lithologic, land use/land cover feature identification and interpretation; Final processing (classification algorithms and statistical analysis).
Familiarization with GIS software systems; Data input; digitization, scanning; Data editing of spatial and non-spatial data, Use of attributes and other tabular data; Data query and analysis, Map making and production; Individual and group assignments.

### GL-P9 Engineering & Environmental Geology

Engineering Geology: Study of maps and models of important engineering structures as dam sites and tunnels. Determination of engineering properties of rocks. Preparation of log chart for drill core logging. Analysis of water-pressure test results. Preparation of 3-dimensional geological logs for tunnels.
Environmental Geology: Study of seismic and flood prone areas in India. Physico-chemical analysis of water samples and their classification for use in drinking, irrigation and industrial purposes. Presentation of chemical analysis data and plotting chemical classification diagrams.

# FOURTH SEMESTER

## Theory

### GL-T13 Special paper

### GL-T13-A Rock Deformation and Structural Analysis

| Unit | Course content |
|---|---|
| 1. | Stress-strain relationship: Three-dimensional strain and stress analysis and its application in deformed rocks. Brittle failure and ductile deformation. Fluids in rocks and the importance of effective stresses, Temperature, time and scale effects on rock strength, Mechanism of deformation |
| 2. | Experimental simulation of structures in laboratory: Experimental deformation of natural rocks. Significance of fractures, and brittle and ductile shear zones. Metamorphic foliation, their types and origin. Determination of fabrics in deformed rocks and interpretation. The relationship between cleavage and finite strain. The development of cleavage in a complex anisotropic material. Experimental and theoretical analyses of linear structure. |
| 3. | Mechanism of deformation: Intracrystalline and intercrystalline slip; microstructures associated with them. Fold shape classifications and projection Techniques of fold orientations. Mechanism of single-layer and multi-layer folds and associated structures. Superposed folds.<br>Buckling of anisotropic rocks, Theory of buckling and finite development of folds in mechanically anisotropic materials. Modeling of folds in anisotropic material using rocks and analogue, Relationship between various structures that develop in anisotropic material. |
| 4. | Use of stereographic and equal-area projections for representing different types of fabrics. Processes of structural analysis on megascopic and macroscopic scales. Examples of structural analysis of area of multiple deformations. |

**Books recommended:**


Davis, G.R., 1984: *Structural Geology of Rocks and Region.* John Wiley.
Ghosh. S. K., 1995: *Structural Geology Fundamentals of Modem Developments.* Pergamon Press.
Hobbs, B. E., Means, W. D. and Williams, P.F., 1976: *An Outline of Structural Geology.* John Wiley.
Lisle, R. J., 1988: *Geological Strain Analysis.* Pergamon.
Price, N. J. and Cosgrove, J. W., 1990: *Analysis of Geological Structure.* Cambridge Univ. Press.
Ramsay, J. G. and Huber, M. I., 1987: *Modem Structural Geology, Vol. 1&/1.* Academic Press.
Ramsay, J. G., 1967: *Folding and fracturing of Rocks.* McGraw Hill. ,
Turner, F. J. and Weiss, L. E., 1963: *Structural Analysis of Metamorphic Tectonites.* McGraw Hill.


## GL-T13-B Sedimentary Environment and Sedimentary Basins

| Unit | Course content |
|---|---|
| 1. | Kinds of sedimentary particles: Morphology of clastic, nonclastic and pyroclatic particles and their use in provenance studies. Study of labortary techniques in sedimentological studies. |
| 2. | Processes of dolomitization and Phosphatization. Origin of various types of cements. Use of trace fossils, stramatolites, thrombolites and related structure in palaeo-environmental analysis. Methods of palaeocurrent determination and basin analysis. |
| 3. | Tectonics and evolution of the sedimentary basins. Sedimentary cycles, rhythems and cyclothems. Analysis of sedimentary facies and preparation of facies maps; Study of lithofacies, biofacies, dynamics and primary structures associated with the following environments: desert, alluvial fans, river plains, glaciers, deltas, estuaries, clastic shorelines, clastic shelves, marine evaporite basins, carbonate platforms, deep sea and ocean bottom, deep sea trench and rise |
| 4. | Sedimentation pattern and depositional environment of selected un-deformed and deformed sedimentary basins of Karewa, Indo-Gangetic and Shiwaliks. |

**Books recommended:**


Bhattacharya, A. and Chakraborti, C., 2000: *Analysis of Sedimentary Successions.* Oxford
Blatt, H., Murray, G. V. and Middleton, R. C., 1980: *Origin of Sedimentary Rocks.* CBS, N. Delhi.
Davis, R. A. Jr., 1992: *Depositional Systems.* Prentice Hall.
Einsele, G., 1992: *Sedimentary Basins.* Springer Verlag.
Friedman, G. M. and Sander, J. E., 1978: *Principles of Sedimentology* John Wiley.
Miall, A. D., 2000*: Principles* of *sedimentary Basin Analysis.* Springer-Verlag.
Prothero,D. R.Schwab, F., 1996: *Sedimentary Geology.* Freeman.
Reading, J. G. 1996: *Sedimentary Environment and Facies.* Black well.
Reineck, H. E. & Singh, I. B., 1975: *Deposition Sedimentary Environment.* Springer-Verlag.
Tucker, M. 1988: *Techniques in Sedimentology*. Blackwell.


## GL-T13-C Advanced Hydrogeology

| Unit | Course content |
|---|---|
| 1. | Hydrographic analysis: Annual, seasonal and storm hydrographs; Water balance studies; Hydrological equilibrium equations, determination of various components at watershed and basin scale, determination of recharge by stream hydrograph and base flow separation; Geological and structural controls of groundwater occurrence (give some case studies); Water level maps; groundwater-surface water interaction. |
| 2. | Partial differential equations governing groundwater flow; Groundwater hydraulics:Groundwater system, groundwater flow equations, Darcy's law, steady and transient unidirectional and radial flow to a well in confined and unconfined conditions, estimation of aquifer parameters with the help of pumping tests. |
| 3. | Groundwater modeling and management: Groundwater budgets, artificial recharge, conjunctive use of surface and groundwater, trends in water resources management; Mathematical modeling: concept, boundary conditions, analytical and numerical methods of solution, Finite element and finite difference models for steady state and transient flow, MODFLOW- introduction, Indian case studies. |
| 4. | Groundwater chemistry: groundwater solution and its chemical constituents, Mineral dissolution, chemical reactions and chemical equilibrium, water-rock interactions, ion exchange; Environmental isotopes in hydrogeology: stable isotopes (oxygen and deuterium), radioisotopes (tritium and carbon-14), isotope fractionation, Global meteoric water line, regional/local meteoric water line, stable isotopes |

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| | in precipitation - continental, seasonal and altitude effects. |

**Books recommended:**


Chow, V. T., 1988: *Advances in Hydrosciences,* McGraw Hill.
Fetter, C. W., 1990: *Applied Hydrogeology*, Merill Publishing.
Freeze, R. A. & Cherry, J. A., 1979: *Ground Water*. Prentice Hall.
Karanth, K. R, 1987: *Groundwater Assessment-Development and Management.* Tata McGraw Hill.
Raghunath, N. M., 1982: *Ground Water.* Wiley Eastern.
Todd, D. K., 1980: *Ground water Hydrogeology.* John Wiley.
Walton, W. C., 1988: *Ground Water Resources Evaluation.* McGraw Hill.


## GL-T13-D Advanced Remote Sensing & GIS

| Unit | Course content |
|---|---|
| 1. | Spaceborne remote sensing system and platforms: IRS, LANDSAT, SPOT, and IKONOS. Multi-spectral and hyper-spectral remote sensing, Geophysical Remote Sensing, Active Microwave remote sensing: SAR images, wavelength, penetration, polarization, topographic influences on SAR images, radar interferometry. Thermal remote sensing: Thermal infrared radiation properties, thermal radiation laws and thermal properties of the terrain. |
| 2. | Multivariate image statistics, Optical remote sensing data filters, radar speckle/noise removal techniques, image data formats (BSQ, BIP and BIL), image ratios, Georeferencing and mosaicing of satellite data, data fusion techniques: integration of optical, radar and geospatial data. Knowledge based image classification, Post classification processing of data, classification accuracy estimation. |
| 3. | Remote sensing application to geosciences: Complimentary use of remote sensing, GIS and field observations. Geological mapping (lithology, structural mapping of faults, folds and suture zones). Use of remote sensing data for snow and glacier mapping, change detection studies (deforestation), Remote sensing for crustal deformation, morphometric and hydrological analysis. |
| 4. | Geospatial data representation techniques, database management systems, Surface mapping and interpolation methods, Digital Elevation Model (DEM) and its development from point, contour and stereo-image data, raster and vector data analysis, Applications of GIS for drainage analysis and active tectonics, use of GIS for flood risk assessment and landslide hazard zonation. |

**Books recommended:**


Burrough, P. A., 2003: *Principles of Geographic Information* Systems. Oxford University Press.
Campbell, J., 2002: *Introduction to Remote Sensing.* Guilford Press, New York.
Demers, M. N., 1999: *Fundamentals of Geographic Information Systems.* John Wiley.
Jensen, J. R., 2004: *Remote Sensing of the Environment.* Prentice Hall, New Jersey.
John, A., Richards, 1993: *Remote Sensing Digital Image Analysis.* Springer-Verlag.
John, R., Jensen, 2000: *Introductory Digital Image Processing, A Remote Sensing Perspective.*
Lillesand, T. M. and Kiefer, RW., 1987: *Remote Sensing in Geology*. John Wiley. Prentice Hall,
Lillesand, T. M. and Kiefer, RW, 2002: *Remote Sensing and Image Interpretation,* John Wiley.
Rees, W. G., 2001: *Physical Principles of Remote sensing.* Cambridge University Press.
Sabbins, F. F., 1985: *Remote Sensing - Principles and Applications.* Freeman
Skidmore, A., 2002. *Environmental modeling with GIS and Remote Sensing.* Taylor & Francis, London.
Longley, D. A., Gordchild, M. F., Maguire, D. J. and Rhind, D. W., 2001: *Geographic Information Systems and Science.* John Wiley & Sons.


## GL-T13-E Oceanography & Marine Geology

| Unit | Course content |
|---|---|
| 1. | Oceanography: An overview, Physiography of ocean floor - Bathymetric provinces. Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. |
| 2. | Waves: Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power. |
| 3. | Marine geomorphology: Introduction, modern deep-ocean mapping, charting and geodesy;<br>Ocean morphology: Feature definitions. Ocean ridges, seamounts, guyots, fracture zones, continental shelf, continental slope and trenches, |
| 4. | Marine sedimentation: Sediments in the sea, Shelf sedimentation, Deep-sea sedimentation |

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| | Sedimentary features Canyons, sea channels, fans, abyssal plains. Distribution of marine microfossils, stratigraphy and geochronometry of deep-sea deposits. Mineral resources of the oceans, Neogene Paleo-oceanography. |

**Books recommended:**


Kennett, J. P., 1982: *Marine Geology.* Prentice Hall.
Pinet, P. R., 1992: *Oceanography, An Introduction to the Planet Oceanus.* West Pub. Co.
Seibold, E. and Berger, W. H., 1982: *The Sea Floor.* Springer-Verlag.
Smoot, N. C., Choi, D. R & Bhat, M. I., 2002. *Marine Geomorphology.* XLIBRIS Corp.
Smoot, N. C., Choi, D. R. & Bhat, M. I., 2002. *Active Margin Geomorphology.* XLIBRIS Corporation
Thurman, H. B., 1978: *Introductory,Oceanography*. Charles, E. Merrill Pub. Co.


## GL-T13-F Petroleum Exploration

| Unit | Course content |
|---|---|
| 1. | Identification and characterization of petroleum source rocks: Amount, type and maturation of organic matter. Oil and source rock correlation. Locating petroleum prospects based on principles of petroleum generation and migration (geological modeling). Quantitative evaluation of oil and gas prospects through geochemical modeling. Migration modeling. Inputs for the assessment of accumulation of petroleum |
| 2. | Elements of geophysical methods of exploration: Magnetic, gravity and seismic methods. Interpretation of seismic data in basin modeling and preparation of subsurface geological maps. Application of remote sensing techniques in basin analysis. |
| 3. | Petroleum provinces and petroliferous basin: Basin studies and basin analysis. Basin classification in plate tectonics. Fundamental types of petroliferous basin; relation between basin type and hydrocarbon richness. Factors favoring hydrocarbon abundance. Petroleum provinces of India and world Case studies of some giant oil fields |
| 4. | Elements of well drilling: Cable-tool drilling, rotary drilling, various types of drilling units. Elements of logging. Electric, radio active and sonic logs. Nuclear magnetic resonance and dielectric logging Application of logs in petro-physical analysis and facies analysis |

**Books recommended:**


Guillemot, J., 1986: Oil and Gas Exploration Techniques. Additions Technip.
Glennie, K. W., 1998: Petroleum Geology of the North Sea. Blackwell Science.
Holson, G. D. and Tiratsoo, E.N., 1985: *Introduction Petroleum Geology*. Gulf Pub. Houston,
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Landon, R. C., 1996: Principles of Petroleum Development Geology. Printice Hall.
North, F. K., 1985: *Petroleum Geology.* Allen & Unwin
Salley, R. C., 1988. *Elements of Petroleum Geology.* Academic Press.
Tedesco, S. A., 1995: Surface Geochemistry in Petroleum Exploration. Chapman Hall.
Tissot, B. P. & Welte, D. H., 1984: *Petroleum Formation and Occurrence,* Springer Verlag.


## GL-D Project work

Project work to be assigned individual decided in consultation with concerned course teachers. Depending upon the requirements, the project work could be undertaken within or outside the Department.

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