# *Master of Science in Geology*


## Course Structure and Syllabus

## 1st to 4th Semester

## Batch 2018 - 2020

| Syllabus for M.Sc. Geology | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Credit and Hours** | | | | **CBSC** |
| | | **L** | **T** | **P** | **Cr** | |
| CST.501 | Computer application * # | 2 | - | - | 2 | *CF* |
| STA.503 | Statistics for Sciences * # | 2 | - | - | 2 | *CF* |
| EGS.506 | Mineralogy and Crystallography | 4 | - | - | 4 | *C* |
| EGS.507 | Paleontology | 4 | - | - | 4 | *C* |
| EGS.508 | Sedimentology | 2 | - | - | 2 | *C* |
| EGS.509 | Mineralogy and Crystallography (Practical) | - | - | 4 | 2 | *C* |
| EGS.510 | Paleontology and Sedimentology (Practical) | - | - | 4 | 2 | *C* |
| EGS.511 | Geomorphology & Geotectonic | 4 | - | - | 4 | *DE* |
| EGS.512 | Environmental Geology and Natural Hazards | 4 | - | - | 4 | *DE* |
| EGS.513 | Natural Resource and Watershed Management | 4 | - | - | 4 | *DE* |
| IDC | Interdisciplinary course | 2 | - | - | 2 | *ID* |
| | **Total** | **20** | **-** | **8** | **24** | |
| **Semester – II** | | | | | | |
| EGS.521 | Geochemistry and Isotope Geology | 4 | - | - | 4 | *C* |
| EGS.522 | Igneous and Metamorphic Petrology | 4 | - | - | 4 | *C* |
| EGS.523 | Structural Geology | 4 | - | - | 4 | *C* |
| EGS.524 | Igneous and Metamorphic Petrology (Practical) | - | - | 4 | 2 | *C* |
| EGS.525 | Structural Geology (Practical) | - | - | 4 | 2 | *C* |
| EGS.526 | Field Geology and Field training – I † | - | - | 2 | 1 | *SB* |
| EGS.542 | Seminar | - | - | - | 1 | *SB* |
| EGS.527 | Oceanography and Climatology | 4 | - | - | 4 | *DE* |
| EGS.528 | Mineral Exploration and Petroleum Geology | 4 | - | - | 4 | *DE* |
| IDC | Interdisciplinary course | 2 | - | - | 2 | *ID* |
| | **Total** | **18** | **-** | **10** | **24** | |

| **Interdisciplinary course offered by the Department** | | | | | | |
|---|---|---|---|---|---|---|
| EGS. 534 | Introduction to Disaster Management | 2 | - | - | 2 | *ID* |

* University level courses will be offered by the Department of Computer Sciences and Technology, Mathematics and Statistics or Computational Science.

# Student can choose suitable MOOC courses instead of CST.501 or STA.503

† Field work will be conducted in the beginning of 2nd semester. This field work will be focused on the sedimentological and paleontological aspect.

Evaluation of this course will be based on the field activity, daily field report, final report submission and presentation.

| Course Code | Course Title | Credit and Hours | | | | CBSC |
|---|---|---|---|---|---|---|
| | | L | T | P | Cr | |
| **Semester – III** | | | | | | |
| EGS.551 | Ore Geology | 4 | - | - | 4 | *C* |
| EGS.552 | Hydrogeology, Remote Sensing and GIS | 4 | - | - | 4 | *C* |
| EGS.553 | Ore Geology, Remote Sensing and GIS (Practical) | - | - | 4 | 2 | *C* |
| EGS.554 | Quantitative Geosciences | - | 2 | - | 2 | *DEC* |
| EGS.555 | Research Methodology | 4 | - | - | 4 | *CF* |
| VAC | Value added Course | - | 1 | - | 1 | *VAC* |
| EGS.543 | Seminar | - | - | - | 1 | *SB* |
| EGS.599 | Project | - | - | 12 | 6 | *SB* |
| | **Total** | **12** | **3** | **16** | **24** | |
| **Semester – IV**: **Core courses** | | | | | | |
| EGS.571 | Principle of Stratigraphy and Indian Stratigraphy | 4 | - | - | 4 | *C* |
| EGS.572 | Engineering Geology and Geophysics | 4 | - | - | 4 | *C* |
| EGS.573 | Engineering Geology and Geophysics (Practical) | - | - | 4 | 2 | *C* |
| EGS.574 | Geological Mapping and Field training – II †† | - | - | 2 | 1 | *C* |
| EGS.575 | Comprehensive Geosciences | - | 2 | - | 2 | *DEC* |
| VAC | Value added Course | - | 1 | - | 1 | *VAC* |
| EGS.599 | Project | - | - | 12 | 6 | *SB* |
| | **Total** | **8** | **3** | **18** | **20** | |
| **Grand total for all semester (I+II+III+IV)** | | **60** | **6** | **52** | **92** | |



†† Field work will be conducted in the beginning of 4th semester. This field work will be focused on the lithological and structural mapping/ ore geology. Evaluation of this course will be based on the field activity, daily field report, final report submission and presentation during the 4th semester.

**L:** Lectures, **T:** Tutorial, **P:** Practical**, Cr:** Credits, **CBCS:** Credit Based Choice System, ***C*** **=** Core**,** ***CF*** **=** Compulsory Foundation**,** ***DE*****=**Discipline Elective, **DEC**=Discipline enrichment course, **SB** = Skill Based Subject, **VAC** = Value added Course

**1. Mode of transaction:** Lecture, Demonstration, Tutorial, Problem solving, Seminar, Group discussion, Field work,

**A. Tools used:** PPT, Video, Animation movie, Whatsapp,

**B. Software Tool:** Stellarium, Celestia, Mineralogical interactive software, crystal maker

**2. Evaluation Criteria for Theory Courses: Total Marks 100**

**a.** Continuous Assessment (25%): Assignments (5%), Term paper (10%), Minimum 3 surprise test (10%)
**b**. Mid-Term Test-1 (25%): Based on Subjective Type Test
**c.** Mid-Term Test-2 (25%): Based on Subjective Type Test
**d.** End Semester Exam (25%): On line MCQ test

## SEMESTER-I

**Course Title: Computer applications**
**Course Code: CST: 501**

| L | T | P | Cr |
|---|---|---|---|
| 2 | - | - | 2 |

**Course objective:** Upon successful completion of this course, the student will be able to:

- Use different operating system and their tools easily.
- Use word processing software, presentation software, spreadsheet software and latex.
- Understand networking and internet concepts.
- Use computers in every field like teaching, industry and research.

**Unit I**

**Computer Fundamentals:** Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.

**Unit II**

**Computer Network:** Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept, WWW.
**Word Processing**: Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.

**Unit III**

**Presentation Tool:** Creating Presentations, Presentation views, working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, and Shortcut keys.
**Spread Sheet**: Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.

**Unit IV**

**Use of Computers in Education and Research**: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.

**Suggested Readings**


1. Sinha, P.K. Computer Fundamentals. BPB Publications.
2. Goel, A., Ray, S. K. 2012. Computers: Basics and Applications. Pearson Education India.
3. Microsoft Office Professional 2013 Step by Step https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/97807356694 13.pdf


**Course Title: Statistics for Sciences**

**Course Code: STA. 503**

| L | T | P | Cr |
|---|---|---|---|
| 2 | - | - | 2 |

**Course objective:** To provide the understanding and use of Statistical techniques for students of other departments.

**Unit I** **8 hours**

**Descriptive Statistics:** Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.



**Unit II** **8 hours**

**Measures:** Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

**Unit III** **8 hours**

**Random variables and Distributions:** Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and continuous distributions like Normal, F and student-t distribution.

**Unit IV** **8 hours**

Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing.

**Parametric tests:** Test for parameters of Normal population (one sample and two sample problems) z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA).

**Non-Parametric tests: One sample**: Sign test, signed rank test, Kolmogrov-Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.

**Suggested Readings**


1. P. L. Meyer, *Introductory Probability and Statistical Applications*, Oxford & IBH Pub, 1975.
2. R. V. Hogg, J. Mckean and A. Craig, *Introduction to Mathematical Statistics*, Macmillan Pub. Co. Inc., 1978.
3. F. E. Croxton and D. J. Cowden, *Applied General Statistics*, 1975.
4. P. G. Hoel, *Introduction to Mathematical Statistics*, 1997.


**Title: Mineralogy and Crystallography**

**Code: EGS. 506**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objective:** This core deals with the study of minerals and their physical, chemical and crystallographic characteristics. Objectives of this course are

- To describe physical and optical properties of minerals
- To explain crystallography and mineral chemistry
- To introduce systematic mineralogy of silicate and non-silicates

**Unit I** **13 hours**

**Mineralogy:** Introduction to mineralogy, broad classification, properties of minerals & environments of formation. Crystal chemistry: chemistry of elements, bonding and packing in mineral, coordination number, chemical analysis of minerals, general and structural mineral formulae. Polymorphs/structural states, rules of substitution, introduction to phase diagram and solid solution series.



**Unit II** **15 hours**

**Crystallography:** Crystal systems, introduction to symmetry, derivation of 32 classes of symmetry.2D and 3D lattice, 14 Bravais lattice, introduction to space group. International system of crystallographic notation and study of stereogram. Different types of crystal projections – spherical and stereographic and their uses.Crystal defects, twinning and twin laws: common types of twins and their examples in minerals. Liquid crystals. Introduction to X-ray crystallography, and Bragg's equation. Powder method in X-ray crystallography.

**Unit III** **12 hours**

**Optical Mineralogy:** Introduction to optics, Isotropic and anisotropic minerals, optical crystallography of uniaxial and biaxial crystals, indicatrix, pleochroism, interference figures, crystal orientation, 2V and 2E.

**Unit IV** **20 hours**

**Systematic Mineralogy:** A detailed study of the important silicates (listed below) and non-silicate mineral with reference to general and structural formulae, classification, atomic structure, polymorphs/structural states,

solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations.

a) Nesosilicates/Orthosilicates: olivine group, garnet group, aluminosilicate group (kyanite, andalusite, sillimanite), humite group, zircon.
b) Sorosilicates: melilite, axinite and epidote group.
c) Cyclosilicates: beryl, tourmaline, cordierite, eudialyte
d) Inosilicates: pyroxene group, amphibole group and wollastonite
e) Phyllosilicates: mica group,kaolinite-serpentine group, talc-pyrophyllite,chlorite, smectite.
f) Tectosilicates: silica group, feldspar group, zeolite and feldspathoid

**Suggested Readings**


1. Mineralogy and Optical Mineralogy by Dyar M. D., Gunter M. E., Tasa D., 2008, Mineralogical, Society of America, ISBN 978-0-939950-81-2.
2. Mineralogy by Perkins Dexter, 2012, Pearson Education.
3. Dana`s Textbook of Mineralogy (With Extended Treatise on Crystallography and Physical Mineralogy), by William E. Ford, 2006, CBS Publishers & Distributors Pvt. Ltd., ISBN 10: 8123908091.
4. Optical Crystallography by Bloss, 1999, Mineralogical Society of America.
5. Crystallography and Crystal Chemistry by Bloss, 1994, Mineralogical Society of America.
6. Introduction to Mineralogy by William Nesse, 2011, Oxford University Press, ISBN: 9780199827381.
7. Introduction to Optical Mineralogy by William Nesse, 2012, Oxford University Press, ISBN: 9780199846276.
8. Minerals and Rocks-Exercises in Crystallography, Mineralogy and Hand Specimen Petrology by Cornelius Klein, 2007, Wiley publisher.
9. Mineralogy by Berry, L.G., Mason, B. and Dietrich, R.V., 2004, CBS Publishers, ISBN 10: 8123911483, ISBN 13: 9788123911489.
10. Introduction to the Rock-Forming Minerals by Deer W.A., Howie R.A. and Zussman J., 2013, Mineralogical Society of America.
11. Rutley's Elements of Mineralogy, by Gribble, 2005, CBS Publishers, ISBN-10: 8123909160.

**Title: Paleontology**
**Code: EGS. 507**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objective:** Paleontology aims in imparting the knowledge of past lives, origin and evolution of lives through time and their response to tectonic and climates.

- To educate various aspects biological events such as origin of life, evolution, mass extinctions, radiations, paleo-ecology, exceptional preservation, and functional morphology.
- To prepare the students for professional job perspective in the field of basic paleontological research, to benefit them in the preparation of various exam.

**Unit I** **15 hours**

Scope of paleontology; Origin and evolution of life through age; species concept and speciation. Techniques in palaeontology: mega fossils, microfossils, nanno-fossils and ichno-fossils–mode of collection and illustration; binomial nomenclature.

Study of Invertebrate paleontology with special reference to functional morphology: trilobites, brachiopods, gastropods and cephalopods general morphology and Indian occurrence.

**Unit II** **15 hours**

Micropaleontology: Classification and uses of micro fossils. Detailed study of microfossils such as Foraminifera, Radiolaria, Conodonta, Ostracoda and Charophyta. Plant fossils: Gondwana flora and their significance.

**Unit III** **15 hours**

Vertebrate palaeontology: General characters, classification, evolution of Fishes including Agnaths, Placoderms, Chondrichythis and Osteichthyes. General characters, age of Amphibians, Reptiles and Mammals. General characters, classification, evolution, age and extinction of Dinosaurs. General characters, classification and evolution of Horse, Elephant and Man. Vertebrate fossil records of Siwaliks. A brief study on the Mesozoic reptiles of India.

**Unit IV** **15 hours**

**Applied Palaeontology**: Use of paleontological data in stratigraphy, biostratigraphy, paleoecology, evolution, paleoclimate and sea level changes; Principle of paleobiogeography.

Use of microfossils in interpretation of sea floor tectonism. Application of micropaleontology in hydrocarbon exploration; oxygen and carbon stable isotopes studies of microfossils and their use in paleoclimate interpretation.

**Suggested Readings**


1. Invertebrate Palaeontology & Evolution by Clarkson, E. N.K., 1998, Wiley-Blackwell.
2. Vertebrate Palaeontology, by Michael Benton, 2004, Wiley-Blackwell.
3. Microfossils, by Howard A. Armstrong, Martin D. Brasier, 2004, Blackwell Publishing Ltd.
4. Principles of Paleontology by Michael Foote, Arnold I. Miller, 2006, W. H. Freeman.
5. Applied Palaeontology by Jones, R.W. 2002, Natural History Museum, London.
6. Principles of Invertebrate Paleontology by Shrock, N., 2005, CBS Publisher & distributer Private Ltd.
7. Paleontology Invertebrate by Henry Wood, 2004, CBS Publication & distributer Private Ltd.
8. Bringing Fossils to Life: An Introduction to Palaeobiology, by Donald R. Prothero, 2003, McGraw-Hill Higher Education.
9. Modern foraminifera by Sen Gupta, B.K. 2003, Springer Netherlands.


**Title: Sedimentology**

**Code: EGS. 508**

| L | T | P | Cr |
|---|---|---|---|
| 2 | - | - | 2 |

**Course objective:** This core deals with the study of sedimentary rocks, their mode of formations, process of sedimentation and environment of deposition.

- To explain different sedimentary rocks, their mode of formation and processes.
- To educate knowledge of different sedimentary basins and their economic importance are also significant for economic and mineral exploration.
- To prepare students for the application of sedimentology in other applied subjects

**Unit I** **8 hours**

Origin of terrigenous clastic and non-clastic grains; weathering and its products; Grain size, textural parameters and their significance. Textural and compositional maturity. Major carbonate minerals; carbonate grains of biological origin. Simple fluid flow concepts and sediment transport; sediment gravity flows and their deposits.

**Unit II** **7 hours**

Petrography and origin of sandstones, limestones and mudrocks. Sedimentary facies, methods of their analysis and interpretation of depositional environments. Processes and characteristics of aeolian, fluvial, barrier-beach, tidal-flats and deep sea environments.

**Unit III** **8 hours**

Important bed forms and sedimentary structures – their genesis and stratigraphic significance. Application of sedimentary structures in palaeocurrent analysis; Diagenesis of clastic and non-clastic rocks; Stages and processes of diagenesis, compaction and cementation by silica, carbonate and iron-oxide, dolomitization. Heavy minerals and their importance in determination of provenance.

**Unit IV** **7 hours**

Tectonic and sedimentation; Review of concept of geosynclines and plate-margins, major types of basins and distribution of environments and lithofacies within basins, evolution of basins with time. Sedimentary basins of India and their economic importance.

**Suggested Readings**


1. Principles of sedimentology & stratigraphy by Sam Boggs, Jr., 2011, Prentice Hall.
2. Sedimentary Geology, by Donald R. Prothero and Fred Schwab; 2013, W. H. Freeman.
3. Carbonate Sedimentology by Tucker, M.E. and Wright, V.P., 1991, Wiley Publisher.
4. Sedimentary Environments: Processes, Facies and Stratigraphy by Reading, H.G., 1996, Wiley-Blackwell.
5. Sedimentology and stratigraphy by Gary Nichols, 2009, Wiley-Blackwell, ISBN: 978-1-4051-3592-4.
6. Atlas of Sedimentary Rocks Under the Microscope by Adams, A. E., MacKenzie, W. S., Guilford, C., 1984, Prentice Hall.
7. Sedimentary Rocks in the Field: A Practical Guide (Geological Field Guide), by Maurice E. Tucker, 2011, Wiley-Blackwell.
8. Principles of Sedimentary Basin Analysis by Miall, A.D., 2000, Springer-Verlag.
9. Sedimentary Basins by Einsele, G., 1992. Springer Verlag.
10. Depositional Sedimentary Environments by Reineck, H.E. and Singh, I.B., 1980, Springer-Verlag.
11. Introduction to Sedimentology by Sengupta, S., 1997, Oxford-IBH.


**Title: Mineralogy and Crystallography (Practical)**
**Code: EGS. 509**

| L | T | P | Cr |
|---|---|---|---|
| - | - | 4 | 2 |

**Course objective:**

- To train the practical aspects of Mineralogy and Crystallography which can be significantly helpful in the identifications of minerals while carrying out future academic research and teaching,
- To train with the practical and hand out problems in laboratory for identification of certain minerals from their crystal forms,

- To explain physical and optical properties of minerals, analysis of raw data generated from XRD, XRF, etc.

**Unit I**

**Mineralogy and crystallography:** Identification of rock-forming minerals in hand specimens. Introduction to crystal models, Goniometer and its use in measuring interfacial angle of crystals and calculation of axial ratio. Representation of symmetry elements of crystals belonging to 32 classes of symmetry and study of their stereograms. Analysis of XRD spectrum.

**Unit II**

**Optical Mineralogy:** Determination of length fast and length-slow characters of minerals. Determination of order of interference colours. Scheme of pleochroism and absorption of a given mineral in thin section. Determination of extinction angle and composition of plagioclase. Study of interference figures of uniaxial and biaxial crystals, determination of optic signs. Identification of rock forming minerals using optical properties.

**Suggested Readings**


1. Minerals and Rocks-Exercises in Crystallography, Mineralogy and Hand Specimen Petrology by Cornelius Klein, 2007, Wiley.
2. Mineralogy by Perkins Dexter, 2012, Pearson Education.
3. Dana`s Textbook of Mineralogy (With Extended Treatise on Crystallography and Physical Mineralogy), by William E. Ford, 2006, CBS Publishers & Distributors Pvt. Ltd.
4. Mineralogy and Optical Mineralogy by Dyar MD, Gunter ME, Tasa D, 2008, Mineralogical, Society of America.
1. Optical Crystallography, by Bloss, 1999, Mineralogical Society of America.
2. Crystallography and Crystal Chemistry by Bloss, 1994, Mineralogical Society of America.
3. Introduction to Mineralogy by William Nesse, 2011, Oxford University Press.
4. Introduction to Optical Mineralogy by William Nesse, 2012, Oxford University Press.
5. Mineralogy by Berry, L.G., Mason, B. and Dietrich, R.V., 2004, CBS Publishers.
6. Introduction to the Rock-Forming Minerals by W.A. Deer, R.A. Howie and J. Zussman, 2013, Mineralogical Society of America.
7. Rutley's Elements of Mineralogy, by Gribble, 2005, CBS Publishers.


**Evaluation Criteria:** Total Marks – 100,
End semester exam (70%), Lab record (15%), Viva (15%)

**Title: Paleontology and Sedimentology (Practical)**
**Code: EGS. 510**

| L | T | P | Cr |
|---|---|---|---|
| - | - | 4 | 2 |

**Course objective:** This paper outlined the general concept of practical works and hand out experiences in laboratory for identification of certain fossils, analysis of fossil data, identification of certain sedimentary rocks, their physical and optical properties under microscope and other process of sedimentary data analysis.

The primary objective of this course to train the practical application of sedimentology and palaeontology to fill up the requirement of the students in carrying out future academic research and teaching assignment.

**Unit I**

Study of clastic and non-clastic rocks in hand specimens. Microscopic examination of important rock-types. 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. Assemblages of sedimentary structures and their palaeo-environmental significance. Palaeo-current analysis. Study of vertical profile sections of some selected sedimentary environment.

**Unit II**

Study of morphology of brachiopods, bivalves and gastropods, cephalopods, echinoids. Separation, processing, wet sieve analyses, preparation of slides of microfossils (demonstration only). Morphology and morphological descriptions of planktonic & benthonic foraminifera, ostracods. Morphology of radiolaria, diatoms, pollen and spores. Construction of range charts.

**Suggested Readings**


1. Atlas of Sedimentary Rocks Under the Microscope by A. E. Adams, W. S. MacKenzie, C. Guilford, 1984, Prentice Hall.
2. Principles of Invertebrate Paleontology by N. Shrock, 2005, CBS publication.
3. A Practical approach to Sedimentology by Roy C. Lindholm, 1987, Allen and Unwin, London.
4. Microfossils by M.D. Braiser, 1980, George Allen and Unwin.
5. Elements of Micropaleontology by Bignot, G., 1985, Grahm and Trottman, London.
6. Introduction to Marine Micropaleontology, by Haq and Boersma, 1978, Elsevier.
7. Systematics & Fossil Record-Documenting Evolutionary Patterns by Smith, A.B., 1994, Blackwell publisher.
8. Micropaleontology in Petroleum exploration by R.W. Jones, 1996, Clarendon Press Oxford.

9. Paleontology Invertebrate by Henry Wood, 2004, CBS Publication.
10. Introduction to Sedimentology by Sengupta, S., 1997, Oxford-IBH.

**Evaluation Criteria:** Total Marks – 100,
End semester exam (70%), Lab record (15%), Viva (15%)

**Discipline Electives: Select any one from the followings.**

**Title: Geomorphology and Geotectonic**

**Code: EGS. 511**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objective:**

- To familiarize the student with the basic concept of geomorphology and its relation with role of tectonics and climate.
- To educate the knowledge of certain landforms, their processes of formation, and the significant response of landforms under the influence of climate and tectonics.

**Unit I** **14 hours**

Development in geomorphology, Historical and process geomorphology, The geomorphic systems,Geomorphic materials and process: weathering, sediment production, pedogenesis, mass movement, erosion, transportation and deposition, landforms in relation to climate, rock type, structure and tectonics.



**Unit II** **16 hours**

Geomorphic processes and landforms-fluvial, glacial, aeolian, coastal and karst. River forms and processes-stream flow, stage-discharge relationship; hydrographs and flood frequency analysis, Submarine relief, Environmental change-causes, effects on processes and landforms. Extra-terrestrial geomorphology.

**Unit III** **14 hours**

Physiography, drainage, climate, soils and natural resources of the Himalaya, Ganga Brahmaputra plains, and peninsular India, climate zones of India. Geomorphology and topographic analysis including DEM, topographical maps, map reading, geomorphic mapping, slope analysis and drainage basin analysis, applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies.

**Unit IV** **16 hours**

Planetary evolution of the earth and its internal structure. Heterogeneity of the earth's crust. Major tectonic features of the oceanic and continental crust. Seafloor spreading and plate tectonics. Island arcs, Oceanic islands and volcanic arcs. Continental drift-geological and geophysical evidence, mechanics, objections, present status. Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains. Isostasy, orogeny and epeirogeny. Seismic belts of the

earth. Seismicity and plate movements. Geodynamics of the Indian plate.

**Suggested Readings**


1. Principles of Geomorphology by W.D. Thornbury, 2004, CBS publisher & distributer private Ltd.
2. Global Tectonics by Philip Kearey, Keith A. Klepeis, Frederick J. Vine, 2009, Wiley-Blackwell.
3. Fundamental of Geomorphology by Richard John Huggett, 2007, Taylor & Francis.
4. Geological Field Techniques by Angela L. Coe (edt), 2010, Wiley-Blackwell.
5. Basic Geological Mapping (Geological Field Guide), by Richard J. Lisle, Peter Brabham, John W. Barnes, Wiley-Blackwell; 2011,ISBN-13: 978-0470686348
6. Geomorphology and Global Tectonics, Michael A. Summerfield (Editor), 2000, Wiley,ISBN: 978-0-471-97193-1,
7. Principles of Physical Geology by Holmes, and edited by P. McL. D. Duff., 1993, Chapman and Hall, London.
8. Applied Geomorphology: Theory and Practice, by R. J. Allison, 2002, Wiley.
9. Tectonic Geomorphology by Douglas W. Burbank, Robert S. Anderson, Wiley-Blackwell; 2011, ISBN-13: 978-1444338867
10. Geomorphology: The Mechanics and Chemistry of Landscapes by Robert S. Anderson, Suzanne P. Anderson, 2010, Cambridge University Press.
11. Key Concepts in Geomorphology by Paul R. Bierman, David R. Montgomery, 2013, W. H. Freeman.
12. Indian Geomorphology by H.S. Sharma, 1991, Concept Publishing Co. New Delhi.
13. Text book of Physical Geology by G.B. Mahapatra, 2008, CBS Publishers & Distributors Private Ltd.
14. Plate Tectonics and Crustal Evolution by Condie, Kent. C., 1997, Butterworth-Heinemann.

**Title: Environmental Geology and Natural Hazards**
**Code: EGS. 512**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objective:**

- To introduces the study of interrelationship between the earth and environment; environmental pollutions, different manmade and natural hazards and precautionary and mitigation measures.
- To study the behaviour of anthropogenic pollutants in the environment and how remedial measures may be applied to cover their harmful effects.
- To train and help the students in spreading the awareness on geological and environmental issues and the tactics of cropping the disastrous scenario, mitigation on hazards and related anticipatory policy measures which will be helpful to protect populations at risk.

**Unit I** **15 hours**

**Introduction to Environmental Geology:** Fundamental concepts of environmental geosciences, its scope and necessity; Definition, structure, composition and general characteristics of lithosphere, hydrosphere, atmosphere and biosphere; Concept of ecology, ecosystem, its structure and functions, types of ecosystem; Biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur; Physiography, drainage, climate, soils and natural resources of India.

**Unit II** **15 hours**

**Environmental issues:** Water pollution : types of water pollution, groundwater pollution sources, pathways and mechanism, attenuation processes, case histories of natural (arsenic and fluoride poisoning) and man-made water pollution; water logging, causes, effects and remedial measures, aquifers; declining groundwater tables, subsidence and compaction of aquifers ; Soil pollution- sources, causes and effects; Soil pollution control measures; Air pollution : definition, terminology, sources and classification of air pollutants; effects of air pollution- acid rain, green house effects and ozone layer depletion; Air pollution control and management.

**Unit III** **15 hours**

**Introduction to Disasters:** Introduction to natural and manmade disasters; Dimensions of natural and anthropogenic disasters; Floods –nature and frequency of flooding, flood hazards, urbanization and flooding, flood hydrographs, Dams barrages and river diversions; Landslides; Coastal hazards – tropical cyclone, coastal erosion, sea level changes, coastal zone management; Earth quakes - Seismic waves, quake resistant buildings and dams; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters.

**Unit IV** **15 hours**

**Risk Assessment and Preparedness:** Pre-Disaster Management activities; Hazard and vulnerability analysis; Hazard zonation maps : preparation and utilization; capability assessment; emergency / contingency planning and post-disaster management activities; Development planning, planning environment, types of plans, MBO, SWOT analysis; Mitigation strategy : Relief measures, community health, casualty management Role of Government, Non-Governmental and media agencies, Reconstruction and Rehabilitation; Awareness through print and electronic media, involving youth in field observations.

**Suggested Readings**


1. Environmental Geology by Barbar W. Murk et al., 1996, John Wiley & Sons, New York.
2. Introduction to Environmental Geology by Edward A. Keller, 2011, Pearson Education publisher.
3. Environmental Geology by K. S. Valdiya, 2013, McGraw-Hill Education (India)
4. Disaster Management and Preparedness by Collins Larry R. and Schneid Thomas D., 2000, Taylor and Francis.
5. Earth Science and the Environment by Graham Thompson and Jon Turk, 2007, Thomson and Brooks/cole.
6. Disaster Management by Goel S.L. and Kumar Ram, 2001, Deep and Deep Publications.
7. Living with Risk: A global review of disaster reduction initiatives, 2004 Vision, United Nations.
8. India Disasters Report: Towards a Policy Initiatives by Parasuraman S., 2004, Oxford University Press.




**Title: Natural Resource and Watershed Management**
**Code: EGS. 513**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objective:** The objective of this course is to provide the information of our natural resources including watershed management in more sustainable way. To explain issues related to the society and its importance.

**Unit I** **15 hours**

Natural resources: Definition; Resource and Reserve; Classification of natural resources; natural resource degradation and conservation; Environmental impacts of resource depletion. Forest Resources: Forest cover of India and world; forest types, functions of forest – production and protection; Conservation of forests; forestry programmes – social forestry, farm forestry, urban forestry, community forestry; deforestation; Exploitation of forest resources; Afforestation; Desertification; Forest policy.

**Unit II** **15 hours**

Water Resources: Surface, ground water, marine and brackish water resources - assessment and utilization; Rivers and Lakes in India; hydrological cycle; Ground water depletion; Water logging and salinity; Water Conservation and management techniques; Rain water harvesting; Watershed management; Eutrophication; Restoration of Lakes; River cleaning, River action plans - Ganga and Yamuna action plan, Interlinking of rivers; conflicts over water.

Land resources: Land degradation due to mining, exploration, industrialization, irrigation and natural disasters; Soil Erosion, Loss of soil fertility, Restoration of soil Fertility, Soil Conservation Methods; restoration of degraded land; Wasteland reclamation, Organic farming, green manuring, Wetland – definition, classification, functions, ecological importance and conservation.

**Unit III** **15 hours**

Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making, problems, approach and components. Structure and relief, physiographic divisions, drainage systems and watersheds. Concept of small dams waste disposal practices and management; rainwater harvesting; Wetland and concept of Micro Watershed Management; Watershed Management using Geo-spatial technologies.

**Unit IV** **15 hours**

Community participation, private sector participation, Institutional issues, Socio-economy, Integrated development; Watershed Management in India, Water legislation and implementations, policies and decision making. Community participation, Private sector participation, Case studies. Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies on flood damage. Drought assessment and classification, drought analysis techniques, drought mitigation planning. Perspective on recycle and reuse, Waste water reclamation.

**Suggested Readings**


1. Environmental economics and natural resource management by Anderson, David A., 2013, Routledge.
2. Land resource management by Gurdev Singh and Vinod Ahuja, 1992, Oxford & IBH Pub. Co.
3. Natural resources and sustainable developments by Kathy Wilson Peacock, 2008, Facts on file Inc.
4. Sustainable natural resource management for scientists and engineers by Lynch, Daniel R., 2009, Cambridge University press
5. Natural resources in 21st century by Jaidev Somesh, 2010, ABD

Publisher
6. Essential Environmental Studies by Panday, S.N. and Misra, S.P. (Eds.), 2008, CRC Press.
7. Watershed Management in India by Murthy, K.S. 1998. Wiley Eastern Ltd. / New Age International Ltd.
8. Watershed Management: Guidelines for Indian Conditions by Tideman, E.M., 1996, Omega, New Delhi.
9. Water of Hope: Integrated Water Resource Development and Regional Co-operation within the Himalayan-Ganga-Brhamaputra-Barak Basin by Verghese, B.G., 1990, Oxford-IBH.

## Semester II

**Title: Geochemistry and Isotope Geology**
**Code: EGS. 521**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course objectives:**

- To introduce the interrelationship between geology and chemistry, study of isotope and their applications in geosciences.
- To provide basic understanding of stable isotope and radiogenic isotope systematic, and their applications in earth sciences.
- To prepare students for future research and teaching career in the field of Geochemistry and Isotope Geology.
- To educate the students regarding earth processes, geochemical processes various tools such as major and trace elemental abundances and their ratios, isotopic studies and quantification approach.

**Unit I** **14 hours**

**Geochemistry**

Introduction of geochemistry and cosmochemistry. Abundance of elements in the solar system and chemical composition and properties of Earth's layers. Atmosphere: its layers, chemical composition and evolution of atmosphere. Meteorites, classification, mineralogy, origin, significance and phenomena of fall.

**Unit II** **15 hours**

Geochemical classification of elements. Periodic table with special reference to rare earth elements and transition elements. Principles of ionic substitution in minerals; Geochemistry of uranium and lithium.

Elemental mobility in surface environment. Concept of geochemical-biogeochemical cycling: Minor cycle and major cycle.

**Unit III** **18 hours**

**Isotope Geology**

Introduction and physics of the nucleus; radioactive decay; the law of radioactive decay; review ofmineral structure; principles of mass spectrometry; K-Ar method: principles, methods andapplications; Ar-Ar method: principles, method and advantages: Rb-Sr method: principles, Rb-Srisochron and limitations. Sm-Nd Method: decay scheme, evolution of Nd with time, Nd model agesand application of Nd to petrogenesis; U-Th-Pb Method: decay schemes, U-Pbisochron, U-Pbmineral dating and application.

**Unit IV** **13 hours**

Stable isotopes and their fractionation; ratio Mass Spectrometry; principles of oxygen, carbon and sulphur isotope geochemistry and their application in Geology. Application of Cosmogenic radionuclides in the geosciences. Principles and application of Fission Track and Radiocarbon methods of dating.

**Suggested Readings**


1. Principles and applications of Geochemistry by Gunter Faure, 1998, Prentice Hall.
2. Essentials of Geochemistry by John V. Walther, 2010, Jones and Bartlett Publication.
3. Isotope Geology by Claude Allegre, 2008, Cambridge University Press.
4. Radiogenic Isotope Geology by Dickin, A.P., 2005, Cambridge University Press.
5. Stable Isotope Geochemistry by Jochen Hoefs, 2015, Springer International Publishing.
6. Principles of Isotope Geology by Gunter Faure, 1986, Wiley.
7. Isotopes: Principles and Applications by Gunter Faure and Teresa M. Mensing, 2004, Wiley
8. Geochemistry, An introduction by Francis Albarede, 2003, Cambridge University Press.
9. Geochemistry by William M. White; 2013, Wiley-Blackwell.
10. Geochemistry: Pathways and Processes by H.Y. McSween Jr., S.M. Richardson and M.E. Uhle, 2003, Columbia University Press,
11. Introduction to Geochemistry by Mason, B. and Moore, C.B., 1991, Wiley Eastern.
12. Introduction to Geochemistry by Krauskopf, K. B., 1967, McGraw Hill.

**Title: Igneous and Metamorphic Petrology**
**Code: EGS. 522**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Objectives:**

- To impart the knowledge of Igneous and Metamorphic rock as a whole, their processes of formations and mineralogical and textural changes evolved with temperatures and pressures.
- To prepare the students for future research and teaching career in the field of Igneous and Metamorphic Petrology.

**Unit I** **14 hours**

Magma: nature of magma, factors affecting magma and evolution, melting of mantle. Generation of magmas in different tectonic environments. The phase equilibrium of unary, binary and ternary systems and its relation to magma genesis and crystallization in the recent experimental works. Interpretation of igneous textures in terms of rate of nucleation and crystal growth.

**Unit II** **16 hours**

IUGS classification of the Igneous rocks. CIPW Norm. Petrology and petrogenesis of ultramafic, basaltic, granitic, alkaline igneous rocks including ophiolite, carbonatite, nephelinite-ijolilte, lammproits, and layered igneous rocks with Indian examples. Plume magmatism and hot spots. Mantle metasomatism. Mantle heterogeneities. Partial melting (batch and fractional melting), crystal fractionation, contamination (AFC process) and dynamic melting.

**Unit III** **15 hours**

Mineralogical phase rule for closed and open systems. Nature of metamorphic reactions, concept and classification of metamorphic facies, Introduction to ultrahigh temperature and ultrahigh pressure metamorphism, description of each facies of low–Pressure, medium to high–pressure and very high pressure with special reference to characteristic minerals, subdivision into zones/sub-facies, Mineral assemblages, Metamorphic reactions and pressure–temperature conditions of metamorphism.

**Unit IV** **15 hours**

Isograds and reaction isograds, Schrienemakers rule and construction of petrogenetic grids, Metamorphic differentiation, anatexis and origin of migmatites in the light of experimental studies, Regional metamorphism and paired metamorphic belts with reference to the theory of plate tectonics, Pressure – temperature – time paths.

**Suggested Readings**


1. An introduction to Igneous and Metamorphic Petrology by Winter, J.D., 2001, Prentice Hall.
2. Principles of Igneous and Metamorphic Petrology by Philpotts, A.R. 1994, Prentice Hall.

3. The Interpretation of Igneous Rocks by Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993, Champman& Hall, London.
4. Igneous and Metamorphic Petrology by Turner, F. J., and Verhoogen, J., 1987, CBS.
5. Igneous and Metamorphic Petrology by Best, Myron G., 2002. Blackwell Science.
6. Origin of Igneous Rocks – The Isotopic Evidence by Faure, G., 2001, Springer.
7. Igneous Petrology by Hall A., 1997, Longman.
8. Igneous Rocks: A Classification and Glossary of Terms by Le Maitre, R.W., 2002, Cambridge University Press.
9. Igneous Petrology by McBirney, 1994, CBS Publishers, Delhi.
10. Modern Igneous Petrology by Sood, M. K., 1982, Wiley-Interscience Publ., New York.
11. Magmatism in Relation to Diverse Tectonic Settings by Srivastava Rajesh, K., Chandra, R. and Balkema, A.A., 1997, Oxford University Press.
12. Petrogenesis of Metamorphic Rocks by Bucher, K. and Martin, F., 2002, Springer – Verlag.
13. An introduction to Metamorphic Petrology by Yardley, B.W.D., 1989, Longman Scientific & Technical, New York.
14. Mineralogical Phase Equillibria and pressure – temperature – time Paths by Spear, F. S. 1993, Mineralogical Society of America.
15. Equilibrium thermodynamics in Petrology: An Introduction by Powell, R. 1978, Harper & Row Publishers, London.
16. Igneous Petrology by Bose, M.K., 1997, World Press, Kolkata.

**Title: Structural Geology**
**Code: EGS. 523**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course Objectives:**

- To give an in depth knowledge of different geological structures associated with deformation processes.
- To educate the application of structural geology in oil and petroleum sectors.
- To prepare the students for future research and teaching career in the field of Structural Geology.

**Unit I** **15 hours**

Stress and analysis of stress in two and three dimension. Plane stress analysis and Mohr stress circle, and its relationship with faulting and fracture mechanics. Mechanical principle, properties of rocks and their controlling factors. Theory of rock failure: brittle failure – shear and tensile failures. Role of fluid pressure and effective pressure in brittle failure.

Strain analysis– finite and infinitesimal, homogeneous and inhomogeneous

strains. Strain and deformation paths. Determination of strain in naturally deformed rocks.

**Unit II** **15 hours**

Description and geometric classification of folds. Mechanics of folding. Fold development and distribution of strains in folds. Brittle and ductile shear zones, Geometry and products of shear zones, Mylonites and Cataclasites; buckling of single layer, multilayer and anisotropic materials. Analysis and interpretation of superimposed folding. Fault bent folds, gravity induced structures and salt diapirism.

**Unit III** **15 hours**

Planar and linear fabrics (Foliation and Lineation) in deformed rocks: description, classification, genesis and significance. Basic idea about petrofabrics and use of Universal stage.

Stereographic and equal area projections for representing different types of fabrics, π and β diagrams. Non-diastrophic structures: significance in the study and analysis of deformed rocks.

**Unit IV** **15 hours**

Description and classification of faults and joints. Mechanics of faulting and jointing, and stress conditions for thrust, normal and strike-slip faults. Mechanics and geometric aspects of thrust, normal and strike-slip faults, and associated structural features. Thin-skinned deformation; Decollement. Geometrical analysis of simple and complex structures on macroscopic scale. Identification of top and bottom of the strata/rock.

**Suggested Readings**


1. Structural Geology by Marland P. Billings, 2000, Phi Learning.
2. Structural Geology by Robert J. Twiss, Eldridge M. Moores, 2006, W. H. Freeman publisher.
3. Structural Geology by Haakon Fossen, 2010, Cambridge University Press.
4. Structural Geology: An Introduction to Geometrical Techniques by Donal M. Ragan, 2009, Cambridge University Press.
5. Techniques of Modern Structural Geology. Vol. I. Strain Analysis by Ramsay, J.G. and Huber, M.I., 1983, Academic Press.
6. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I., 1987, Academic Press.
7. Folding and fracturing of rocks by Ramsay, J.G., 1967, McGraw Hill.
8. Basic Methods of Structural Geology by Stephen Marshak and GautamMitra. 1988, Prentice Hall.
9. An outline of Structural Geology by Hobbs, B.E., Means, W.D. and Williams, P.F., 1976, John Wiley and Sons. New York.
10. Structural Geology: Fundamental and Modern Developments by Ghosh, S.K., 1993, Pergamon Press.

**Title: Igneous and Metamorphic Petrology (Practical**
**Code: EGS. 524**

| L | T | P | Cr |
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| - | - | 4 | 2 |

**Course Objective:**

- To train practical works and hand out experiences in laboratory for identification of certain Igneous and metamorphic socks in hand specimen and in petrological thin section.
- To educate the students for solving the practical problems in data analysis and interpretation.
- The primary objective of this course to train the practical application of Igneous and Metamorphic Petrology which will fill up the requirement of the students in carrying out future academic research and teaching assignment.

**Unit I**

Rock analyses (rapid method of silicate analysis). Determination of Loss on Ignition (LOI) of rock samples. Preparation of classificatory and variation diagrams and their interpretation. Study of non-silicate minerals and elements. Megascopic and microscopic study of different igneous rocks. Calculation of CIPW Norms.

**Unit II**

A detailed study of textures in Rock Sections with reference to time relations between the phases of deformation and recrystallization of minerals, Calculation of ACF, AKF and AFM values from chemical and structural formulation of minerals and their graphical representation. Study of Metamorphic Rocks in hand specimens and thin sections belonging to different facies with emphasis on texture/structure, mineral composition, parent rock, metamorphic facies / subfacies.



**Suggested Readings**

1. Igneous Rocks: A Classification and Glossary of Terms by LeMaitre, R.W., 2002, Cambridge University Press.
2. An introduction to Igneous and Metamorphic Petrology by Winter, J.D., 2001, Prentice Hall.
3. Principles of Igneous and Metamorphic Petrology by Philpotts, A.R. 1994, Prentice Hall.
4. The Interpretation of Igneous Rocks by Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993, Champman & Hall, London.

**Evaluation Criteria:** Total Marks – 100,
End semester exam (70%), Lab record (15%), Viva (15%)

**Title: Structural Geology (Practical)**
**Code: EGS. 525**

| L | T | P | Cr |
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**Course Objective:**

- To educate the application of the processes of Tectonics and geological structures: Deformation, plate tectonics and earthquakes.

- To train the students in solving the practical structural problems.

**Unit I**

Preparation and interpretation of Geological maps and sections. Structural problems based on orthographic and stereographic projections, concerning economic deposit. Recording and plotting of the structural data on base map.

**Unit II**

Study of the hand specimen of deformed structures, Strain estimation from the data already collected from the field. Study of dip-isogons from the fold profiles.

**Suggested Readings**


1. Basic Methods of Structural Geology by Stephen Marshak and GautamMitra. 1988, Prentice Hall.
2. Structural Geology: Fundamental and Modern Developments by Ghosh, S.K., 1993, Pergamon Press.
3. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I., 1987, Academic Press.


**Evaluation Criteria:** Total Marks – 100,
End semester exam (70%), Lab record (15%), Viva (15%)

**Title: Field Geology and Field training - I**
**Code: EGS 526**

| L | T | P | Cr |
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| - | - | 2 | 1 |

**Course Objective:**

- To learn the practice of theoretical knowledge for applying at ground observation in field and to learn essential observational and practical skills.
- The emphasis on field geology is designed to help the students to gain experience of identifying rocks and interpreting the physical (including tectonic) processes that may have been involved in their formation.
- Students on Geology courses will have subject knowledge and which will be followed by field trip and formulated their knowledge in field trip and will learn different rock type, different deformational structures, such as fold, fault, lithology and depositional features etc.
- To train the students for adaptation in field work environment in certain professional and scientific organizations.

**Unit I** **15 hours**

Field Geology: Introduction to toposheets, Scale definition; small scale and large scale maps; reading various components of a toposheet. Geological map-definition, various components of a geological map including scale, legend, structures and, etc. Studies of outcrop pattern, topographic law and rules of 'V'.Instruments used in geological field studies; techniques and use of geological tools during field work-use of clinometer compass, Brunton

compass, GPS, altimeter; strike and dip measurements; Identification of lithology, structure, and their environmental and tectonic significances, measurement of true thickness and distance, section measurement techniques and significance.

**Unit II**

Field work up to 10 days will be conducted in the beginning of 2nd semester. Evaluation of this will be based on the field activities, daily field report, final report submission and presentation, content, style of presentations and the satisfaction on discussion/ question answers with the evaluators and audiences.

**Suggested Readings**


1. Geological field techniques by Angela L. C. 2010, Blackwell Publishing Ltd.
2. Basic Geological Mapping (Geological Field Guide) by Lisle, R. J., Brabham, P. and Barnes, J. W., 5th edition, 2011, Wiley-Blackwell.
3. Guide to Field Geology by Mathur, S.M., 2001, PHI Learning Private Limited-New Delhi.
4. Field geology (Illustrated) by Maley, T.S., 1994, Mineral Land Publications.
5. Field geology by Lahee, F. H., 6th edition, 1961, McGraw-Hill.


**Evaluation Criteria**: Full Marks – 100

Field activity (10%), Evaluation of field dairy during every day of field work and final submission (20%), Final field report (40%), Presentation (30%) – Presentation will be evaluated as style (5%), content (5%), understanding (10%) and question & answer (10%).

**Title: Seminar**

**Code: EGS. 542**

| L | T | P | Cr |
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**Course Objective:**

- To enhance the presentation skill and of the student.
- To introduce how the scientific research paper, any subject matter organized for presentation and how it will attract attention of audience.
- Student will learn how to take participation in the discussion and question /answer session.

Students will be assigned with a topic, research article, book chapter or any subject related topic to prepare a report and presentation. Scheduled seminars will be conducted in the department in the presence of experts.

**Evaluation Criteria**- Full mark 100

It will be evaluated based on Literature strength, Organization of content, report evaluation**,** presentation, discussion and question answer.

**Discipline Elective 1: Select any one**

**Title: Oceanography and Climatology**

**Code: EGS. 527**

| L | T | P | Cr |
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**Course Objective:**

- The objectives of this course are to provide the details of the components of the ocean, sea floor, chemical constituents, physical components, and life forms which comprise one of Earth's largest interacting, interrelated, and interdependent systems.
- To introduce the basic concepts of climatology includes scientific study of climate, mean weather conditions.
- Students will also obtain the knowledge of atmospheric condition and various agents affecting the earth surface.

**Unit I: Oceanography** **15 hours**

Origin, evolution of ocean basins and their environmental response; Topographic features of the ocean floor; Classification of marine sediments, sedimentation processes; Wave dynamics; Ocean circulation: forces driving currents; thermohaline circulation; equatorial upwelling, coastal upwelling, down welling; Tides - equilibrium theory of tides, dynamical theory of tides, tidal currents in coastal areas, observation and prediction of tides.

**Unit II** **15 hours**

Seawater chemistry: salinity - components, sources and processes controlling the composition of sea water; Density structure of ocean; inputs of organic carbon, concept of food chain; primary production, measuring productivity, factors limiting productivity, Marine resources: Petroleum and Natural Gas, sand and gravel, manganese and phosphate nodules, metallic sulfides and muds.

Origin and evolution of the Indian Ocean, structure and physiography of the Indian Ocean, bathymetry and bottom characteristics, sediment distribution on the Indian Ocean floor. Petroleum occurrences and exploration activity around the margins of the Indian Ocean. India's Exclusive Economic Zone (EEZ); marine minerals in the EEZ of India.

**Unit III: Climatology** **13 hours**

Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiations: Radiation laws, short wave and long wave radiations; Albedo; Emissivity; Radiation Budget of Earth; Application of meteorological principles to transport and diffusion of pollutants, Topographic effects.

**Unit IV** **17 hours**

The boundary layer; Inversion; Local microclimate; Greenhouse effect; Radiation balance; Precipitation; Atmospheric movements; Distribution of radiation; Rotation of earth- Coriolis acceleration, angular momentum; General meridional circulations: Hadley cells; Middle latitudes; Circulation

of water and energy in atmosphere; Weather, and Climate in India; El Nino, La Nina, seasons and monsoons; Climatic classification schemes; Biogeographical regions of the world; Climate change-Emissions and Global warming, impact on sea level in south Asian region; Environmental disruptions and their implications; Indian climatology with special reference to seasonal distribution and variation of temperature, humidity, wind and precipitation; Agro-climatic zones of India.

**Suggested Readings**


1. Oceanography-An invitation to Marine Science by Garrison T., 1996, Wadsworth

Publishing Company

2. Oceanography - A view of the Earth by Gross, M.G., 1972, Prentice-Hall.
3. Introductory Oceanography by Thurman, B.Y., 1978, Charles E. Merill Publishing Company.
4. Climatology, by Lal, D. S., 2011, Sharda Pustak Bhavan.
5. General climatology by Critchfield, H. J., 2009, PHI Learning, New Delhi.
6. Introduction to geomorphology by Kale, V. S. and Gupta, A., 2001, Orient Longman, Bangalore.
7. Physical geography by Singh, S., 2011, Prayag Pustak Bhavan, Allahabad.
8. An introduction to physical geography by Strahler, A.N. and Strahler, 1996, John Wiley & Sons, UK.
9. Principles of Oceanography by S. Davis, R.A. Jr. 1972, Addison - Wesley Publishing

Company.

10. The Indian Ocean: Exploitable mineral and petroleum Resources by Roonwal, G.S., 1986, Narosa Publishing House.
11. Geological Oceanography: Evolution of coasts, continental margins & the deep-sea floor by Francis P. Shepard, 1977, Pan Publication.
12. Oceanography – Exploring the planet Ocean by Bhatt J.J., 1978, D. van Nostrand Company.


**Title: Mineral Exploration and Petroleum Geology**
**Mineral**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Code: EGS. 528**

**Course objective:**

- To educate an overview of mineral resources, mineral exploration methods, mining plan, petroleum Geology and well logging techniques.
- To educate the students for working in many professional organization

like ONGC, Oil India Limited, MECL, Coal India Limited, etc.

**Unit I** **14 hours**

**Mineral Economics :** Distribution of mineralresources in India; Magmatic, hydrothermal and surface processes of ore formation; Active ore-forming systems; Geological setting, characteristics, and genesis of ferrous, base and noble metals. Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps; Petroliferous basins of India; Classification, rank and grading of coal; coal resources of India; Gas hydrates and coal bed methane.

**Unit II** **15 hours**

**Mineral Exploration Methods:** Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales; Sampling, assaying and evaluation of mineral deposits; methods of mineral deposit studies including ore microscopy, fluid inclusions and isotopic systematic; ores and metamorphism- cause and effect relationships; Methods of petroleum exploration.

**Unit-III** **15 hours**

**Occurrence and Source rocks:** Classification and composition of Petroleum; Physical properties of petroleum; Occurrence of petroleum; Nature of source rock, composition of biomass; Kerogene: Composition and types; Reservoir rocks, pore space and fluids; Reservoir Traps; Origin, migration and accumulation of petroleum. Basin Analysis.

**Unit-IV** **15 hours**

**Indian Oil Fields- Prospecting and Drilling:** Oil bearing basins of India and the world; India's position as regards to petroleum and natural gas future prospects; Geophysical prospecting for petroleum; Drilling, logging and subsurface correlation. Importance of micropaleontology in the field of petroleum exploration.

**Suggested Readings**


1. Geology of Petroleum by Leverson, 2006, CBS.
2. Elements of Petroleum Geology by Selley, R.C., 1997, Atlantic publishers & distribution Pvt. Ltd, Delhi.
3. Geology of Petroleum by Emmons, W. H., 2015, Sagwan press.
4. Introduction to geophysical prospecting by Dobrin, M. B. and Savit, C. H., 1988, McGraw-Hill Inc.
5. An Introduction to Geophysical Exploration by Kearey, P., Brooks, M. and Hill, I., 2002, Wiley-Blackwell.
6. Principles of Applied Geophysics by Parasnis, D. S., 1986, Chapman and Hall.

7. Geochemistry in mineral exploration by Hawkes, H. E., Webb J. S., In eds., Croneis, C., 2012, Literary Licensing, LLC.
8. Mineral Exploration: Principles and Application by Haldar, S. K. 2013, Elsevier.
9. Introduction to Mineral Exploration by Moon C. J., Whateley, M. K. G. and Evans, A.M., 2005, Blackwell Science.
10. Introduction to geophysical prospecting by Dobrin, M. B. and Savit C. H., 1988, McGraw-Hill Inc.
11. An Introduction to Geophysical Exploration by Kearey, P., Brooks M. and Hill, I., 2002, Wiley-Blackwell.
12. Geochemistry in mineral exploration by Hawkes, H. E., Webb J. S., In eds., Croneis, C., 2012, Literary Licensing, LLC.

## Interdisciplinary course (IDC) offered by the Department

**Title: Introduction to Disaster Management**
**Code: EGS. 534**

| L | T | P | Cr |
|---|---|---|---|
| 2 | - | - | 2 |

**Course objective:**

The main objectives of this course are to make aware of both the Natural and Artificial disaster, their management techniques and familiarize the students with the foundations and the recent trends in disaster management.



**Unit I** **7 hours**

Disaster Management: definition, scope, Objectives and Approaches; concept of hazard, risk, vulnerability and disaster, Elements of Disaster Management.

**Unit II** **8 hours**

Classification of disasters- natural disasters and human induced disasters; disasters in India- earthquake, landslide, flood, cyclone, industrial disasters, etc.

**Unit-III** **7 hours**

Disaster mitigation: Concept, importance, tools, strategies with reference to specific disasters; disaster preparedness: Concept, nature, measures, disaster preparedness plan.

**Unit-IV** **8 hours**

Role and responsibility of Central, State, District and Local Administration, Armed Forces, NGOs, media, etc.; Disaster relief; Reconstruction planning; A brief introduction to the mechanism of disaster management in India.

**Suggested Readings**

1. Ahmad, A. (2010): *Disaster Management: Through the New Millennium*, Anmol Publications, New Delhi.

2. Bryant Edwards (2005). Natural Hazards, Cambridge University Press, U.K.
3. Bureau of Indian Standards (2002). Indian Standards: Criteria for Earthquake Resistant Design of Structures, Part I, Fifth Revision.
4. Burton, I., Kates, R.W. and White, G.F. (1993). *Environment as Hazard*, 2nd edition, Guilford Press, New York.
5. Central Water Commission (1989). Manual of Flood Forecasting, New Delhi.
6. Goel, S.L., (2006): *Encyclopedia of Disaster Management*, Deep and Deep Publications, New Delhi.
7. Gosh, G.K., (2012): *Disaster Management*, A.P.H. Publishing Corporation, New Delhi 8.
8. Government of India, (2004): *Disaster Management in India -A Status Report*.
9. Government of India (1997). Vulnerability Atlas of India (New Delhi: Building Materials and Technology Promotion Council, Ministry of Housing & Urban Poverty Alleviation).
10. Government of India, (2005): *Disaster Management in India*, http://www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf.
11. Gupta, H.K., (2003): *Disaster Management*, Universities Press (India) Private Limited, Hyderabad.
12. Kapur, A (2005). *Disasters in India: Studies of Grim Reality*, Rawat Publications, Jaipur.
13. Kapur, A. (2010). Vulnerable India: A Geographical Study of Disasters, Sage Publications, New Delhi.
14. NDMA (2009): National policy on Disaster Management, http://nidm.gov.in/PDF/policies/ndm_policy2009.pdf.



## Semester III

**Title: Ore Geology**

**Code: EGS.551**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course Objective:**

- Students will learn what ore deposits are and many important factors in their origin.
- Students will also learn about different type of ore deposit and their geological settings.
- Students will be able to calculate an ore grade and determine whether an ore deposit is economic based on its grade, size, and production costs.
- They will also learn about the occurrence of metallic/non – metallic minerals; and coal & petroleum in India.
- The main motive of this subject is to provide basic and applied knowledge to the students.

**Unit I** **14 hours**

Modern concept of ore genesis; mode of occurrence of ore bodies – morphology and relationship of host rock and migration, wall-rock alteration. Structural, physicochemical and stratigraphic controls of ore localization. Paragenesis, paragenetic sequence and zoning in metallic ore deposits. Spatial and temporal distribution of ore deposits – a global perspective. Earth's evolutionary history and evolutionary trends in ore deposits. Ore deposits in relation to plate tectonics.

**Unit II** **14 hours**

Mineralogy, classification and genesis of petrological ore associations: Ortho-magmatic ores of ultramafic-mafic association, ores of felsic-silicic igneous rocks: ores related to submarine volcanism, biochemical, chemical and clastic sedimentation; placers and residual concentration deposits. Ores of metamorphic affiliations. Hydrothermal ore deposits. Principle of Fluid inclusions in ore: assumptions, limitations and applications. Geothermo-barometry and isotope studies in ore geology.

**Unit III** **14 hours**

Study of ore minerals related to the following metals such as such Fe, Mn, Cr, Cu, Pb, Zn, Al, Mg, Au, Sn and W with special reference to their mineralogy, genesis, uses in important industries and their distribution in India. Strategic, critical and essential minerals. Importance of minerals in national economy and mineral policy. Mineral concessional rules of India. Law of the Sea.

**Unit IV** **14 hours**

Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Indian coal deposits. Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Geographical and geological distributions of onshore and offshore petroliferous basins of India. Methods of petroleum exploration. Surface and subsurface exploration, gas hydrate and coal bed methane. Nuclear and Non-conventional source of energy.

**Suggested Readings**


1. Introduction to Ore-forming processes by Robb, L., 2005, Blackwell Publ., Oxford.
2. Ore geology and industrial minerals by Evans, A.M., 1992, Blackwell Science.
3. Understanding mineral deposits by Misra, K.C. 1999, Kluwer Academic Publishers.

4. Mineral economics by Sinha, R. K. and Sharma, N.L., 1970, Oxford & IBH.
5. Economic mineral deposits by Jensen, M.L. and Bateman, A.M., 1981, John Wiley & Sons.
6. Ore Petrology by Stanton, R. L., 1972, McGraw Hill.
7. The Geology of Ore Deposits by Guilbert, J. M. and Park, Jr. C. F., 1986, Freeman.
8. Geochemistry of Hydrothermal Ore Deposits by Barnes, H.L., 1979, John Wiley:
9. Economic Geology: Economic Mineral Deposits (Second Edition) by Umeshwar Prasad, 2014, CBS Publishers & Distributors Pvt. Ltd., New Delhi.

**Title: Hydrogeology, Remote Sensing and GIS**
**Code: EGS 552**

| L | T | P | Cr |
|---|---|---|---|
| - | - | 4 | 2 |

**Title: Ore geology, and Remote Sensing and GIS (Practical)**

**Code: EGS. 553**

**Course Objective:** This course will introduce physical, optical and chemical properties of various ore and industrial minerals to the students. It will also provide sound knowledge to identify different ore and industrial minerals. Student will learn application of remote sensing and GIS in geology.

1. Megascopic study of Indian metallic ores and industrial minerals in hand specimens.
2. Study of optical properties and identification of important ore minerals under ore-microscope.
3. Preparation of maps showing distribution of metallic minerals in India and also classical world mineral deposits.
4. Preparation of maps showing distribution industrial minerals in India and also classical world mineral deposits.
5. Estimation of grade, tonnage of ore deposits.
6. Interpretation of borehole logs.
7. Determination of photo scale.
8. Determination of height of objects, dip of bed, slope and thickness of beds by Parallax bar.
9. Study of landforms and interpretation of lithology and structure from aerial photographs and satellite images
10. Identification of landforms on toposheets, aerial photographs and satellite images

**Suggested Readings**

1. Mineral deposit evaluation by A.E. Annels, 1992, Chapman and Hall, London.

2. Ore geology and industrial minerals by Evans, A.M. 1992, Blackwell Science.
3. Remote sensing and image interpretation by Lillisand, T. M. and Keifer, R. W., 2007, John Willey and Sons, USA.

**Evaluation Criteria:** Total Marks – 100,
End semester exam (70%), Lab record (15%), Viva (15%)

**Title: Quantitative Geosciences**
**Code: EGS. 554**

| L | T | P | Cr |
|---|---|---|---|
| - | 2 | - | 2 |

**Course Objective:**

- To enhance the ability to solve quantitative problems of geosciences.
- To introduce various numerical and map based problems to the students.
- This course will be helpful for students to face various national level competitive exams.

This course will be conducted as tutorial classes. In this course student will solve quantitative problems of geosciences in time bound manner. Various numerical problems of geosciences will be discussed and solved in the classes. Problems will cover all the aspects of geosciences. Past question papers of national level exams will be discussed in the classes.

**Evaluation Criteria**- Full mark 100
End semester exam (70%), Assignment based evaluation (15%), Surprise test (15%)



**Title: Research Methodology**
**Code: EGS.555**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

**Course Objective:** The course will make the students aware about types, approaches and methods of research in geology and orient the students to design and prepare geological research proposal, with emphasis on problem identification, methodology design and literature review. This course will introduce concepts and uses of various instruments and sample preparation.

**Unit I** **15 hours**

Concept and definition of Research: academic research, basic and fundamental research, applied research, theoretical, conventional and experimental research. Concepts and needs of research hypothesis. Research proposal and concepts; developing research proposal in the field of geosciences; research approach and identifying gap areas from literature review; problem formulation and statement of research objective.

**Unit II** **15 hours**

Literature survey and review, use of digital library, online resource; necessity of review of literatures. Problem formulation and statement of research objective; Developing of bibliography. Concepts on plagiarism, ISSN and ISBN numbers, impact factors and citation index of research articles and assessing the quality of research articles.

**Unit III** **15 hours**

Pre-field preparations, Field mapping and documentation, Procedure of sampling, Introduction to field mapping and section measurement, Introduction to working principles, concepts, sample preparation, applications and limitations of X-ray Diffractions (XRD), Scanning Electron Microscope (SEM), ICP MS, X-ray fluorescence (XRF),Energy-dispersive X-ray spectroscopy(EDS, EDX, or XEDS), Mass spectrometer, OSL and Fission Track Dating.

**Unit IV** **15 hours**

Types of data: primary and secondary data, Source and authenticity of secondary data, Introduction on the techniques of data representation, documentation and representation tools, basic presentation structures, writing a scientific paper, abstract and summary writing and organizing thesis, project reports; Integrative approach in geology.



**Suggested Readings**


1. Qualitative Research Methods for Social Sciences by Bruce, L. B. 2001, Allyn and Bacon, Boston.
2. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by John, W. C., 2011, Sage Publications, Thousand Oaks.
3. Principles of Writing Research Papers by Lester, James, D. and Lester Jr. J. D., 2007, Longman, New York.
4. Silicate rock analysis by P. J. Potts, 1997.
5. Recent developments in geochemical microanalysis: Chemical Geology by Reed, S. J. B., 1990, Volume. 83, PP. 1-9.
6. Handbook of Instrumental Techniques for Analytical Chemistry by Frank A. Settle, 1997, Prentice Hall, Upper Saddle River, NJ.


**Title: Seminar**
**Code: EGS. 543**

| L | T | P | Cr |
|---|---|---|---|
| - | 1 | - | 1 |

**Course Objective:**

- To enhance the presentation skill and of the student.
- To introduce how the scientific research paper, any subject matter organized for presentation and how it will attract attention of audience.
- Student will learn how to take participation in the discussion and question /answer session.

Students will be assigned with a topic, research article, book chapter or any subject related topic to prepare a report and presentation. Scheduled seminars will be conducted in the department in the presence of experts.

**Evaluation Criteria**- Full mark 100

It will be evaluated based on Literature strength, Organization of content, report evaluation**,** presentation, discussion and question answer.

**Title: Project work 06 Credit [Total Marks: As Satisfactory]**
**code: EGS 599**

Each candidate required to submit a dissertation/ project report based on his/her research work carried out towards the fulfillment of his/her M.Sc. dissertation.

It will have following components**:**

a. Origin of the research problem and literature review
b. Objective of the research work
c. Methodology of the work, field observations (if any) and data recorded by the candidate,
d. Details of laboratory investigation (if any) carried out by the candidate,
e. Synthesis of results and interpretation
f. Concluding remarks and future direction



The 60 % of the marks will be awarded by the teacher(s) who supervised the respective student. A board of examiners will conduct viva-voce, and would consist of the supervisor, faculty member(s) of the department, and other faculty members appointed by the competent authority. The committee will award the rest 40% of the marks including those of presentation and viva-voce. A candidate who does not submit the project report or fails to get pass marks in it will appear again in viva-voce examination of the same class M.Sc. II year in a subsequent year as per university rule.

**Semester IV**

**Title: Principle of Stratigraphy and Indian Stratigraphy**
**Code: EGS. 571**

| L | T | P | Cr |
|---|---|---|---|
| 4 | - | - | 4 |

Course Objective:

- The student will get an idea of basic introduction to principle of stratigraphy.
- It introduces the concepts of Sequence Stratigraphy, system tracts, and sequence bounding surfaces and formation of source and reservoir rocks with the base level cycle.
- The study will also be followed by the Precambrian crustal evolution and stratigraphy of Indian.

**Unit I** **12 hours**

**Principle of Stratigraphy:** History and development of stratigraphy; stratigraphic procedures (surface and subsurface), concept of lithofacies and biofacies; stratigraphic correlation (litho, bio- and chronostratigraphic correlation). Study of standard stratigraphic code (lithostratigraphic, biostratigraphic and chronostratigraphic); Concepts of magneto stratigraphy, chemo stratigraphy, event stratigraphy, and sequence stratigraphy.

**Unit II** **18 hours**

**Archaeans-Precambrian stratigraphy of India:** Precambrian stratigraphic framework of India; Classification, structure and tectonics of the Dharwar craton; Ancient supracrustal (Sargur Type); Gold bearing schist belts of Eastern Karnataka (Kolar Type); Younger schist belts (Dharwar Type); Gneiss complex, granulites, charnockites; Structure, tectonics and stratigraphy of the OMG, OMTG, Iron Ore Group (Singbhum Craton); Stratigraphy of the Sukma, Bengpal, and Bailadila series from Central India; Ancient granites, viz. Singbhum, Chitradurga, etc.; Archaeans of the Extra Peninsular region; Archaean-Proterozoic boundary; Stratigraphy, geology, tectonics and evolution of the following Proterozoic basins/Purana formations in India - Delhi-Aravalli Supergroup, Singbhum Group, Sausar-Sakoli Groups, Vindhyans, Cuddapah, Pranhita-Godavari, Bhima, Kaladgi.



**Unit III** **18 hours**

**Palaeozoic stratigraphy**: Igneous activities and palaeogeography during the Palaeozoic Era. Stratigraphy, facies, and fossil contents of the Palaeozoic rock formations of Peninsular and extra-peninsular India. Permian-Triassic boundary.

**Gondawana stratigraphy**: Concepts, classification, fauna, flora and age limits of Gondwana Supergroup and related palaeogeography, palaeoclimate, depositional characteristics and igneous activity.

**Mesozoic stratigraphy:** Classification, depositional characteristics, fauna and flora, age limits, correlation of Triassic, Jurassic and Cretaceous systems in principal basins of Peninsular and extra-peninsular India. Stratigraphy of the Deccan volcanic province; Cretaceous-Tertiary boundary.

**Unit IV** **12 hours**

**Cenozoic stratigraphy**: Classification, depositional characteristics, fauna and flora of the Palaeogene and Neogene systems in their type localities and their equivalents in India. Epoch boundaries of the Cenozoic in India. Quaternaries of Peninsular India; Neogene-Quaternary boundary. Stratigraphy and tectonics of the Siwalik. Quaternary relative sea level changes

**Suggested Readings**


1. Principles of sedimentology & stratigraphy by Sam Boggs, Jr., 2011, Prentice Hall.
2. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998, New Age, ISBN-13: 978-0852267455.
3. Geology of India by Ramakrishnan, M. and Vaidyanathan R., 2008, Vol. 1 & 2, Geological Society of India, Bangalore, ISBN No: 978-81-85867-98-4.
4. Precambrian Geology of India by Naqvi, S.M. and Rogers, J.J.W., 1987, Oxford University Press.
5. Geology of India and Burma by Krishnan, M.S., 1982, C.B.S. Publishers & Distributors, Delhi.
6. Sedimentology and stratigraphy by Gary Nichols, 2009, Wiley-Blackwell, ISBN: 978-1-4051-3592-4.
7. Introduction to stratigraphy and paleontology, in Indian ocean geology and biostratigraphy (eds J.R. Heirtzler, H.M. Bolli, T.A. Davies, J.B. Saunders and J.G. Sclater), by Bolli, H. M. and Saunders, J. B., 1977, American Geophysical Union, Washington, D. C.
8. Principles of Stratigraphy by Danbar, C.O. and Rodgers, J., 1957, John Wiley & Sons.
9. A Manual of the Geology of India & Burma (Volume I – IV) by Pascoe, E.H., 1968, Govt. of India Press, Delhi
10. The Cenozoic Era? Tertiary and Quaternary by Pomerol, C., 1982, Ellis Harwood Ltd., Halsted Press.
11. Stratigraphy: Principles and Methods by Schoch, R.M., 1989, Van Nostrand Reinhold, New York.
12. Unlocking the Stratigraphic Record by Doyle, P. and Bennett. M.R., 1996, John Willey.




**Title: Engineering and Geophysics**

**Code: EGS. 572**

| L | T | P | Cr | Marks |
|---|---|---|---|---|
| 4 | - | - | 4 | **100** |

**Course Objective:**

- The students will learn the fundamentals necessary for an understanding of the workings of the solid Earth geophysics in the context of plate tectonics.
- Importance of civil engineering as a mining geologist or civil engineer.
- Will learn about rock foundations (building and mining planning) according to the need of different building structures.

**Unit I** **15 hours**

Role of engineering geology in civil constructions. Various stages of engineering geological investigation for civil engineering projects. Soil

mechanics – three phases of soil, consistency limits, particle size distribution, soil classification, consolidation and compaction, and shear strength of soil. Engineering properties of rocks; rock discontinuities. Physical characters of building stones. Metal and concrete aggregates.

**Unit II** **15 hours**

Geological consideration for evaluation of dams, reservoir sites, highways, etc. Dam foundation rock problems. Geotechnical evaluation of tunnel alignments and transportation routes, method of tunneling; classification of ground for tunneling purposes; various types of support. Introduction to various types of mining methods and its planning.

**Unit III** **15 hours**

Introduction to geophysics; characteristics of planet and planetary motions, shape and size of earth; Relative motion of plates, Stability of triple junction, gravitational and magnetic field of the earth, principles of gravity methods and instrument used, corrections applied to gravity data; principles of magnetic methods; instruments of magnetic surveying, Field procedure in conducting magnetic surveys and data reductions.

**Unit IV** **15 hours**

Seismic methods: principles and instruments used; seismic velocity and interpretation of seismic data; Seismic refraction and reflection methods. Geometry of refraction and reflection paths in a layered earth. Seismic noise; Reflection and refraction field methods. Electrical methods: basic principles and various types of electrode configuration; Electrical resistivity method, self-potential and resistively surveying; field procedures and interpretation of field data. Applications of electrical and electromagnetic methods in solving geological problems.

**Suggested Readings**


1. Fundamentals of Engineering Geology by Bell, F.G., 1992, Aditya Books Pvt. Ltd. Indian Edn.
2. Principles of Engineering Geology by Krynine, D.H. and Judd, W.R., 1998, CBS Edition. Delhi.
3. Environmental Geology by Bermett, M.R. and Doyle, P., 1999, John Wiley & Sons, N. York.
4. Fundamental of Geophysics by Lowrie, W., 1997, Cambridge Univ. Press. London.
5. The Solid Earth: An Introduction to Global Geophysics by CMR Fowler, 2005, Cambridge University Press.
6. Applied Geophysics by Telford, W.M., Geldart, L.P. and Sheriff, R.E., 1990, Cambridge University Press.

**Further readings**


7. Fundamentals of Rocks Mechanics by Jaeger J., Cook N. G. and Zimmerman R., 2007, Wiley-Blackwell
8. Engineering Geology for Civil Engineers by Reddy, D.V., 1995, IBH Publishing Co. Pvt. Ltd.
9. Introduction to Seismology, by Peter Shearer, 1999, Cambridge University Press, Cambridge.
10. Looking Into the Earth: An Introduction to Geological Geophysics by Alan E. Mussett, M. Aftab Khan, 2000, Cambridge University Press.


**Title: Engineering geology and Geophysics (Practical)**

| L | T | P | Cr |
|---|---|---|---|
| - | - | 4 | 2 |

**Code: EGS. 573**

**Objective:**

- This introduces students the practical knowledge to geophysical field equipment's and exemplifies how a geophysical problem is posed, experiments designed, data acquired and processed to obtain information about the deep Earth.

*1)* Earthquake epicentral location from travel time data *(graphical).*
2) Fault plane solution of an earthquake from teleseismic records.
3) Seismic wave propagation *(graphical)* problems.
4) Interpretation of seismic and resistivity data for exploration and structural purpose.
5) Study of gravity data maps and their interpretation.
6) Study of properties of common rocks with reference to their utility in engineering projects.
7) Study of maps and models of important engineering structures as dam sites and tunnels.
8) Interpretation of geological maps for landslide problems.
9) Various problems of soil and rock mechanical properties.
10) Calculation of various geo-engineering aspects.

**Suggested Readings**


1) Introduction to Seismology by Peter Shearer, 1999, Cambridge University Press.
2) Inverse Problem Theory and Model Parameter Estimation by Albert Tarantola, 2005, SIAM.
3) The Solid Earth: An Introduction to Global Geophysics by CMR Fowler, 2005, Cambridge University Press.
4) Fundamentals of Engineering Geology by Bell, F.G., 1992, Aditya Books

Pvt. Ltd. Indian Edn.

5) Principles of Engineering Geology by Krynine, D.H. & Judd, W.R., 1998, CBS Edition, Delhi.

**Title: Geological Mapping and Field Training - II**

| L | T | P | Cr |
|---|---|---|---|
| - | - | 2 | 1 |

**Code: EGS 574**

**Course Objective:**

- The subject will include at least one week field trip. It is a great way to apply your knowledge to the real world and learn essential observational and practical skills.
- Our field trips are designed to help the students to gain experience of identifying rocks and interpreting the physical processes that may have been involved in their formation.
- Students on Geology courses will have to spend at least 7-10 days in field for mapping the geology of an areas (depend on the prospective mining or continental elevated region), will learn different rock type, different deformational structures, such as fold, fault, lithology and depositional features etc.

**Unit I**

*Geological mapping procedures:* Geological mapping of igneous terrains, geological mapping of sedimentary terrains, geological mapping of metamorphic terrains and recording of structural information, preparation of Geological Cross-section.

Techniques for sample collection: Sampling and oriented sampling, its significance; sampling for isotopic, geochronological and geochemical studies and its significance.

**Unit II**

Field work up to 10 days will be conducted in the beginning of 4$^{th}$ semester. This field work will be focused on the sedimentological and paleontological aspect. Evaluation of this will be based on the field activities, daily field report, final report submission and presentation, content, style of presentations and the satisfaction on discussion/ question answers with the evaluators and audiences.

**Suggested Readings**


1. Geological field techniques by Angela L. C. 2010, Blackwell Publishing Ltd.
2. Basic Geological Mapping (Geological Field Guide) by Lisle, R. J., Brabham, P. and Barnes, J. W., 2011, Wiley-Blackwell.
3. Guide to Field Geology by Mathur, S.M., 2001, PHI Learning Private Limited-New Delhi.
4. Field geology (Illustrated) by Maley, T.S., 1994, Mineral Land Publications.
5. Field geology by Lahee, F. H., 1961, McGraw-Hill.

**Title: Quantitative Geosciences**
**Code: EGS. 554**

| L | T | P | Cr |
|---|---|---|---|
| - | 2 | - | 2 |

**Course Objective:**

- This course will be helpful for various national level competitive exams.
- To enhance the skill to answer geological question during competitive exams.

This course will be conducted as tutorial classes. In this course student will solve geological questions in time bound manner. Various numerical problems of geosciences will be discussed and solved in the classes. Problems will cover all the aspects of geosciences. Past question papers of national level exams will be discussed in the classes.

**Evaluation Criteria**- Full mark 100

End semester exam (70%), Assignment based evaluation (15%), Surprise test (15%)

**Title: Project work** **06 Credit [Total Marks: As Satisfactory]**
**code: EGS 599**

Each candidate required to submit a dissertation/ project report based on his/her research work carried out towards the fulfillment of his/her M.Sc. dissertation.

It will have following components**:**

a. Origin of the research problem and literature review
b. Objective of the research work
c. Methodology of the work, field observations (if any) and data recorded by the candidate,
d. Details of laboratory investigation (if any) carried out by the candidate,
e. Synthesis of results and interpretation
f. Concluding remarks and future direction

The 60 % of the marks will be awarded by the teacher(s) who supervised the respective student. A board of examiners will conduct viva-voce, and would consist of the supervisor, faculty member(s) of the department, and other faculty members appointed by the competent authority. The committee will award the rest 40% of the marks including those of presentation and viva-voce. A candidate who does not submit the project report or fails to get pass marks in it will appear again in viva-voce examination of the same class M.Sc. II year in a subsequent year as per university rule.