# STRUCTURE AND DETAILED SYLLABUS
# POSTGRADUATE COURSE (M.SC.) IN GEOLOGY
# LEARNING OUTCOME BASED CURRICULUM
# (CHOICE BASED CREDIT SYSTEM)

## FOR AFFILIATED COLLEGES
## COMMON COURSE STRUCTURE FOR M.SC., GEOLOGY – 2021-2022

**MANONMANIAM SUNDARANAR UNIVERSITY**

**TIRUNELVELI- 627012**

2021

**MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI**
**PG - COURSES – AFFILIATED COLLEGES**
**Course Structure for M.Sc. Geology**
**Learning Outcome based Curriculum**
**(Choice Based Credit System)**
**( with effect from the academic year 2021- 22 onwards)**

---

***Vision of the University***

To provide quality education to reach the un-reached

***Mission of the University***

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

**Name of the Programme** : **M.Sc Geology**

**Preamble of the Programme**

Geology is the study of the Earth, the materials of which it is made, the structure of those materials, and the processes acting upon them. It includes the study of organisms that have inhabited our planet. An important part of geology is the study of how Earth's materials, structures, processes and organisms have changed over time. Geology can also refer generally to the study of the solid features of any celestial body (such as the geology of the Moon or Mars. Master's degree course in Geology would be of 90 credits. In this context the University introduce integrated BSc-MSc course in Geology to reduce the disparity between the need and availability of competent professionals to cater the requirements of our nation. This programme is basically an academic programme which focuses on preparing the students for research, as well as, for application of Geological knowledge in various Field settings.

| PROGRAMME STRUCTURE | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Semester** | **Course Code** | **Course** | **Course Nature** | **Credits** | **Contact Hours per Week** | **Continuous Internal Assessment (CIA)** | **End Semester Exam (ESE)** |
| I SEMESTER | | Dynamic Geology and Geomorphology | Core-1 | 4 | 6 | 25 | 75 |
| | | Advanced Palaeontology | Core-2 | 4 | 6 | 25 | 75 |
| | | Structural Geology | Core-3 | 4 | 6 | 25 | 75 |
| | | Indian Stratigraphy or Field Geology or Climatology | Elective-1 | 4 | 4 | 25 | 75 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Dynamic Geology & Geomorphology and Advanced Palaeontology | Practical-I | 3 | 4 | 50 | 50 |
| | | Structural Geology and Elective-1 | Practical-II | 3 | 4 | 50 | 50 |
| | | **Total** | | 22 | 30 | | |
| II SEMESTER | | Mineral Sciences | Core-4 | 4 | 6 | 25 | 75 |
| | | Marine Geosciences | Core-5 | 4 | 6 | 25 | 75 |
| | | Advanced Hydrogeology | Core-6 | 4 | 6 | 25 | 75 |
| | | Advanced Remote Sensing and GIS or Isotope Geology or Urban Geology | Elective-2 | 4 | 4 | 25 | 75 |
| | | Mineral Sciences and Marine Geosciences | Practical-III | 3 | 4 | 50 | 50 |
| | | Advanced Hydrogeology and Elective -2 | Practical-IV | 3 | 4 | 50 | 50 |
| | | | | **22** | 30 | | |
| III SEMESTER | | Igneous Petrology | Core-7 | 4 | 6 | 25 | 75 |
| | | Sedimentary Petrology | Core-8 | 4 | 6 | 25 | 75 |
| | | Research Methodology | Core-9 | 4 | 6 | 25 | 75 |
| | | Fuel and Applied Geology or Mining Geology and Geotechnical Studies or Nanogeoscience | Elective-3 | 4 | 4 | 25 | 75 |
| | | Igneous Petrology and Sedimentary Petrology Practical | Practical-V | 3 | 4 | 50 | 50 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Research Methodologyand Elective-3 Practical | Practical-VI | 3 | 4 | 50 | 50 |
| | | | | **22** | 30 | | |
| | | Metamorphic Petrology | Core-10 | 4 | 6 | 25 | 75 |
| | | Economic Geology and Mineral Economics | Core-11 | 4 | 6 | 25 | 75 |
| | | Advanced Geophysics and Geochemistry | Core-12 | 4 | 6 | 25 | 75 |
| IV SEMESTER | | Metamorphic Petrology | Practical-VII | 3 | 4 | 25 | 75 |
| | | Economic Geology andMineral Economics & Advanced Geophysics and Geochemistry | Practical-VIII | 3 | 4 | 50 | 50 |
| | | Field studies and VIVA VOCE | Practical-IX | 2 | 0 | 50 | 50 |
| | | Dissertation and VIVA VOCE | Practical-X | 4 | 4 | 50 | 50 |
| | | | Total | 24 | 30 | | |
| | | | Grand Total | 90 | 120 | | |

**Scheme of Evaluation:**

***(a) CIA***

i. Theory Course : 25 Marks
ii. Practical* : 50 Marks
iii. Project : No internal
iv. Internship* : ----
v. Field visit* : No internal

(At least one Seminar presentation in a semester and a minimum of one Assignment in each unit by a student)

***(b)ESE***

vi. Theory Course : 75 Marks
vii. Practical* : 50 Marks

viii. Project : 100 Marks
ix. Internship* : ---
x. Field visit* : 100 Marks

***(c) Model End Semester Question Paper****

| SECTION | TYPE OF QUESTION | MARKS |
|---|---|---|
| **Part A** | Multiple Choice Questions<br>(Two questions from each Unit) | 1 x 10 = 10 marks |
| **Part B** | Internal Choice Questions<br>(One Question from each Unit) | 5 x 5 = 25 marks |
| **Part C** | Internal Choice Questions<br>(One Question from each Unit) | 5 x 8 = 40 marks |
| | **Total** | **75 Marks** |

***(d) Passing Minimum***
CIA – No passing minimum (3 Internal Tests – Average of the best 2 will be considered)
ESE – 50%
Cumulative Aggregate – 50%

## ELIGIBILITY NORMS FOR ADMISSION TO M.Sc. GEOLOGY

Candidates for admission to the M.Sc., Degree (Geology) Course shall be required topass the final examinatio recognized and approved by theSyndicate of the Manonmaniam Sundaranar University, Tirunelveli.

**PROGRAMME OUTCOMES** (POs):

- **PO1** SCIENTIFIC KNOWLEDGE - Applying the knowledge of Geology and its allied sciences to Geo-resource inventory and Natural Disaster management.
- **PO2** PROBLEM ANALYSIS : Identify, formulate and solve Geological and technical problems.
- **PO3** CONCEPTUALIZE/DEVELOP SOLUTIONS : Conceive and develop solutions to societal problems related to geological processes and to understand their origin and nature.
- **PO4** CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS : Conduct experiments &collect, analyze and interpret Geological data.
- **PO5** MODERN TOOL USAGE : Apply various mapping tools and techniques, usage of geological, geophysical and geochemical equipment to improve the understanding of the earth system science.
- **PO6** COMMUNICATION**:** Proficiency in oral and written Communication.
- **PO 7** PROJECT MANAGEMENT AND FINANCE IMPLEMENT : cost effective and improved geo resource and geo hazard management system.
- **PO8** LIFE-LONG LEARNING: Continue professional development and learning as a life-long activity

**PROGRAMME SPECIFIC OUTCOMES** (PSOs) :

- **PSO 1**: Systematic or coherent understanding of the academic and professional fields of Geology, its different learning areas and applications.
- **PSO 2:** PSO1 Knowledge of Geological discipline Demonstrate Understanding and in-depth knowledge of the geological processes, geological resources and geodynamics
- **PSO 3**: Procedural knowledge that can create essential skills for different types of jobs related to Geology, in research & development, consultancy, teaching, policy making and administrative service, and equip to cope with emerging developments of Geosciences.
- **PSO 4**: Knowledge to demonstrate the ability to use skills in Geology and its related areas of technology for formulating strategies to tackle geosciences related problems, by applying appropriate geological principles, methodologies and technologies.
- **PSO 5**: Analytical ability to examine, identify and evaluate different geological materials and carry out their characterization using geological, geophysical, and geochemical

modeling techniques. The students acquire skills in geological field mapping & survey, computer techniques and software, microscopy, rock-mineral-ore-fossil characterization, groundwater dynamics, natural hazards and environmental issues related to Earth and other planetary bodies. The student will be able to understand the spatial and temporal relationships between Earth processes & products, and evolution.

- **PSO 6**: Relevant generic skills and global competencies such as a) problem-solving skills that are required for different types of geoscience-related problems, and present well-defined solutions; b) investigative skills, including independent investigation using geoscience- related mapping and the repertoire of geological tools; c) communication and personal skills such as the ability to work both independently and in teams.
- **PSO 7**: Comprehensive professional behaviour such as a) being objective, unbiased and truthful in all aspects of work, avoiding unethical, irrational behaviour such as fabricating, falsifying or misrepresenting data or committing plagiarism; b) the ability to identify ethical issues; c) appreciation of intellectual property, environmental, gender and sustainability issues; and d) promoting safe learning and working environment.
- **PSO8** Research methodologies and Research Ability Ability to think, visualize and search in various domains to identify research gaps and hence to provide solution to new ideas and innovations

**PROGRAMME EDUCATIONAL OBJECTIVES** (PEOs):

- **PEO1** Imparting geological knowledge and skills to gain employment in Industry, Science and research organizations and service sectors.
- **PEO2** Produce quality manpower in geology that can elevate and lead the organization effectively
- **PEO3** Enable the students to understand and bring solutions to societal problems related to Geology
- **PEO4** Motivate students to pursue higher studies and research in Geology
- **PEO5** Create an environment to auger entrepreneurial skills that will innovate and market geology related products.

**PEO / PO Mapping**

| PROGRAMME EDUCATIONAL OBJECTIVES | PROGRAMME OUTCOMES | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 |
| I | X | X | X | X | | | | |
| II | | | | | | X | X | X |
| III | | | X | X | X | | | |
| IV | | | | X | X | X | X | X |
| V | | | X | | | X | X | X |

| MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Subject Status** | **Subject Title** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **YEAR 1** | **SEM 1** | Core-1 | Dynamic Geology and Geomorphology | X | X | X | X | X | X | X | X |
| | | Core-2 | Advanced Palaeontology | X | X | X | X | X | X | X | X |
| | | Core-3 | Structural Geology | X | X | X | X | | X | X | X |
| | | Elective-1 | Indian Stratigraphy or Field Geology or Climatology | X | X | X | X | X | X | X | X |
| | | Practical-I | Dynamic Geology & Geomorphology and Advanced Palaeontology | X | X | X | X | X | X | | X |
| | | Practical-II | Structural Geology and Elective-1 | X | X | X | X | X | X | | X |
| | **SEM 2** | Core-4 | Mineral Sciences | X | X | X | X | X | X | | X |
| | | Core-5 | Marine Geosciences | X | X | X | X | | | X | X |
| | | Core-6 | Advanced Hydrogeology | X | X | X | X | X | X | X | X |
| | | Elective-2 | Advanced Remote Sensing and GIS or Isotope Geology or Urban Geology | X | X | X | X | X | | X | X |
| | | Practical-III | Mineral Sciences and Marine Geosciences | X | X | X | X | X | | X | X |
| | | Practical-IV | Advanced Hydrogeology and Elective -2 | X | | X | X | | X | X | X |

| MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Subject Status** | **Subject Title** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
| **YEAR 2** | **SEM 3** | Core-7 | Igneous Petrology | X | X | X | X | X | X | X | X |
| | | Core-8 | Sedimentary Petrology | X | X | X | X | X | X | X | X |
| | | Core-9 | Research Methodology | X | X | X | X | | X | X | X |
| | | Elective-3 | Fuel and Applied Geology or Mining Geology and Geotechnical Studies or Nanogeoscience | X | X | X | X | X | X | X | X |
| | | Practic al-V | Igneous Petrology and Sedimentary Petrology | X | X | X | X | X | X | | X |
| | | Practical-VI | Research Methodology and Elective-3 | X | X | X | X | X | X | | X |
| | **SEM 4** | Core-10 | Metamorphic Petrology | X | X | X | X | X | X | | X |
| | | Core-11 | Economic Geology and Mineral Economics | X | X | X | X | | | X | X |
| | | Core12 | Advanced Geophysics and Geochemistry | X | X | X | X | X | X | X | X |
| | | Practical-VII | Metamorphic Petrology | X | X | X | X | X | | X | X |
| | | Practical-VIII | Economic Geology and Mineral Economics & Advanced Geophysics and Geochemistry | X | X | X | X | X | | X | X |
| | | Practical-IX | Field studies and VIVA VOCE | X | | X | X | | X | X | X |
| | | Practical-X | Dissertation and VIVA VOCE | X | X | X | X | X | X | X | X |

## MANDATORY REQUIREMENTS FOR M.SC GEOLOGY PROGRAMME

1. **Geological Mapping** will be conducted in an area determined by the Professor-in-charge for the duration of 10 days for I M.Sc Geology students together. Each student have to submit his/her Geological Mapping report separately during II M.Sc final practical exams and there will be VIVA VOCE during Field studies Practical Exam.

2. **Short field trip**: Students have to complete at least two short field trip as determined by the Professor in- charge during First and Second year. A report on the short field trip is to be submitted by the individuals at the end of Second Year practical examinations. There will be VIVA VOCE during Field studies Practical Exam.

3. **Industries or In-plant Training**: Students have to undergo industrial training in any of the industries or implant/professional training in any of the industries, mining or institutes related to geosciences during first year summer holidays, in the form of groups/ individual. A report on the industrial training is to be submitted at the end of Second Year course during the Practical examination. There will be a viva voce on it.

4. **Geological Long Field Trip**: II M.Sc., Geology students have to undertake long field trip of duration of about three weeks to places of geological interest as determined by the Professor- in-charge. Submission of separate field report along with the specimens collected at the end of Second Year during the Practical examination is mandatory. There will be VIVA VOCE during Field studies Practical Exam.

5. **Dissertation**: Students have to carry out a research project. The problem, area and topic will be determined by the Professor-in-charge during the course of study. Each student shall submit a dissertation at the end of second year course during the practical examination. There will be a viva voce during dissertation Practical Exam.

   All the above activities carry both marks and credit

## DYNAMIC GEOLOGY AND GEOMORPHOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- This course aims to import knowledge on the endogenic processes of earth an understanding of plate tectonics and its resultant processes like earthquakes, Isostasy and mountain building activity.
- Geomorphology part provides an overview of landforms, land forming process and landscape evolution. In particular it aims shed light on various land forming processes and how these depend on climate and tectonic regimes and time.

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the landforms created by natural agents |
| **CO2:** | Understand the basics of geochronology and the different dating techniques and their limitations |
| **CO3:** | Apply the philosophy and different thoughts of environmental dynamism and passivism and compare and analyse different landscape evolution models |
| **CO4:** | Analyze the origin of various landforms, the concept of morphogenetic regions and influence of climate and structure on it and evaluate the Land forms and structures as geomorphic indicators of neotectonic movements. |
| **CO5:** | Evaluate the drainage pattern and network characteristics of drainage basin and understand the Soil Formation |
| **CO6:** | Create the model for dynamic nature of the Earth processes and the geodynamics of the lithosphere, concept of Isostacy, continental drift, plate tectonics, volcanism, earth quakes etc. |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT-I**

Continental Drift: Concept –evidences in support of continental drift- Wilson Cycle. Sea-floor spreading: Hess's concept and evidences of sea-floor spreading. Plate Tectonics: Concept-Assumptions – Elements of tectonics – Lithosphere plates: Characteristics, Plate boundaries: Typesof boundaries, Recognition, Migration, Motion of plates, Causes, mechanism and effects of plate movement–Mineral deposits along plate boundaries. Limitations of Plate tectonics theory.

**UNIT-II**

Island arc systems: Single and double chain – General features – Causes for the arc, Evolution of Arc- Trench gap. Rock magnetism, Remnant magnetism: Magnetic reversals; Polar wandering curve – Geomagnetic time scale. Submarine canyons origin and distribution.

**UNIT-III**

Crustal Deformation and Mountain Building: Crustal Deformation: Causes Rocks to Deformation- Types of Deformation- Factors that affect rocks deformation- Mountain Building- Subduction& Mountain Building- Collisional Mountain Belts- Origin of Himalayas- Vertical Motions of the Crust. Isostasy: Gravitational balance – Hypothesis of Pratt Airy, Heiskanen, Daly and Veining Meinesz – Isostatic adjustment – Effects. Volcanic landforms–rift valley formations –oceanic landforms.

**UNIT-IV**

Definition of Geomorphology. Evolution of geomorphic concepts. Principles/laws of geomorphology. Endogenic and exogenic driving forces. Resisting forces. Dynamic equilibrium of driving and resisting forces and Threshold. Landforms created by wind, river, groundwater, Glacier and volcanism.

**UNIT-V**

Geomorphic sub-divisions of Indian sub-continent – Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands. Modern concepts, quantitative geomorphology, process geomorphology. Application of Geomorphology in groundwater exploration, environmental and natural resource management. Geomorphic mapping methods and tools.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| **CO1** | Remember the landforms created by natural agents | PO1 | H | PSO2, PSO3 | H | K1 |
| **CO2** | Understand the basics of geochronology and the different dating techniques and their limitations | PO1, PO2 | H | PSO2, PSO4 | H | K2 |
| **CO3** | Apply the philosophy and different thoughts of environmental dynamism and passivism and compare and | PO4, PO6, | M | PSO5, PSO6 | M | K3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | analyse different landscape evolution models | | | | | |
| **CO4** | Analyze the origin of various landforms, the concept of morphogenetic regions and influence of climate and structure on it and evaluate the Land forms and structures as geomorphic indicators of neotectonic movements. | PO3, PO5 | M | PSO5, PSO7 | M | K4 |
| **CO5** | Evaluate the drainage pattern and network characteristics of drainage basin and understand the Soil Formation | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| **CO6** | Create the model for dynamic nature of the Earth processes and the geodynamics of the lithosphere, concept of Isostacy, continental drift, plate tectonics, volcanism, earth quakes etc. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Radhakrishnan, V., (1996). General Geology V.V.P. Publishers, Tuticorin.
2. Arthur Holmes (1992) Principles of Physical Geology: Thomas Nelson & sons London.
3. Charles C. Plummer, Diane H. Carlson and Lisa Hammersley (2019). 'Physical Geology'(16$^{th}$Ed). McGraw-Hill Education.
4. Strahler A.M (1965). Introduction to Physical Geology., Wiley.
5. Thornbury.W.D( 1969). Principles of Geomorphology., Wiley, New York.
6. Savindra Singh (1998). Geomorphology. Published by Prayag PustakBhavan, Allahabad.
7. Robert S. Anderson, Suzanne P. Anderson(2010). Geomorphology. ,Cambridge UniversityPress.
8. Ro Charlton (2007) Fundamentals of Fluvial Geomorphology., Routledge, Canada.
9. Richard John Huggett (2017) Fundamentals of Geomorphology., Routledge, Canada.
10. Kenneth J. Gregory (2010) The Earth's Land Surface: Landforms and Processes inGeomorphology., SAGE Publications Ltd.
11. Bloom.A.L. (1992), Surface of the Earth, Prentice Hall India, New Delhi

12. Gass, I.G., Smith, P.S & Wilson, R.C.L., 2ndEdt., (1972), Understanding the Earth, The EnglishLanguage Books Society, London
13. Leopold,L.S, Wolman, K & Miller, J.P, (1970), Fluvial processes in Geomorphology, EurasiaPublishing House Pvt Ltd., New Delhi.
14. Robert, S.A. and Suzanne, P.A.,(2010) Geomorphology – The mechanics and chemistry oflandscapes. Cambridge University Press.
15. Routledge N. Y. Ritter,D.F., Kochel, R.C.,Miller, J.R.,(2002) Process Geomorphology,Waveland press.

# ADVANCED PALEONTOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To gain knowledge on concepts and theories of evolution, morphology of fossils and vertebrate Palaeontology.*
- *To understand the early life forms and evolutional history.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the basic of paleontology |
| **CO2:** | Understand the evolution of vertebrates and extinction events, and the record of plant fossils and its significance |
| **CO3:** | Apply the philosophy and different thoughts of environmental dynamism and passivism and compare and analyse different landscape evolution models |
| **CO4:** | Analyze Compare morphology, classification, evolutionary trends of Invertebrate fossils with geological, geographic distribution and paleo-ecological and paleo environmental relevance. |
| **CO5:** | Evaluate evolutionary trends in various Vertebrates. |
| **CO6:** | Create the analyzed data for microfossils, their morphology, palaeoecology and applications in petroleum exploration |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Origin and evolution of life – Phylogenetic and Ontogenic Analysis – Species Concept – Types of Fossils and Types of Species – Palingensis – Coenogensis – Proterogenesis - Thanatocoenosis – Biocoenosis – Sidocoenosis - Biomineralisation and Trace Fossils – Fossils and their uses – Biometrics – Major events in the history of Precambrian and Phanerozoic life.

**UNIT II**

Functional morphology, evolution and significance of Plant Fossils, Fishes, Horse, Elephant and Man. Dinosaurs and their extinction. Archaeopteryx. Gondwana and Tertiary Flora of India.

**UNIT III**

Functional morphology and evolution of Brachiopoda,Trilobita, Graptolites,Pelecypoda, Gastropoda, Cephalopoda, Coelenterata and Echinodermata.

**UNIT IV**

Sampling methods, sample processing techniques and Bathymetric distribution of Microfossils. Morphology, classification, Geological history, Ecology, and Palaeoecology of Foraminifera and ostracods. Morphology of spores and Pollen and its classification.

**UNIT V**

Morphology, Classification, Geological history, Ecology and Palaeoecology of Bryozoaand Diatoms. Environmental significance of Microfossil, Determination of Age and Correlation of Palaeofacies and Tectonism from micro faunal evidence. Isotope studies of fossils and Paleoclimate – Palaeobiogeographic Provinces.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the basic of paleontology | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the evolution of vertebrates and extinction events, and the record of plant fossils and its significance | PO1,PO2 | H | PSO2, PSO4 | H | K2 |
| CO3 | Apply the philosophy and different thoughts of environmental dynamism and passivism and compare and analyse different landscape evolution models | PO4, PO6, | M | PSO5, PSO6 | M | K3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO4 | Analyze Compare morphology, classification, evolutionary trends of Invertebrate fossils with geological, geographic distribution and paleo-ecological and paleo environmental relevance. | PO3, PO5 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate evolutionary trends in various Vertebrates. | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create the analyzed data for microfossils, their morphology, palaeoecology and applications in petroleum exploration | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Henry woods (2011) Invertebrate Palaeontology , 8th Ed, Cambridge.
2. Romer , A.S. (1945) Vertebrate Palaeontology, Chicago press.
3. Arnold, C.A.( 1972) An introduction to Palaeobotany., MC-Graw Hill.
4. B.U. Hag and A. Boersma (1978) : Introduction to marine Micropalaeontology. Elsevier, Netherlands
5. Jain, P.C., and Anatharaman, M.S. (2016) An introduction to Paleontology, VishalPublications.
6. Foote, M. and Miller, I.A. (2007) Principles of Paleontology. 3rd Edition by W. H. Freemanand company
7. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution. 4th Edition by BlackwellPublishing.
8. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons. 4th Edition.
9. Dasgupta, A.,(2005), Introduction to Palaeontology, (1st Edition), World Press
10. Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ.
11. Benton, M. J., (1990).Vertebrate Palaeontology, Chapman & Hall, London.

12. Anis Kumar Ray, (2008) Fossil in Earth science, Prentice Hall of India pvt. Ltd.
13. Colbert, H. Edwin (1961). Evolution of the Vertebrates, John Wiley and Sons.
14. Stanley, S.M., (1986) Earth and life through time, W.H. Freeman and company, 1986.
15. Berry, E.W. An introduction to Palaeontology, Sonali publications, 2004.

## STRUCTURAL GEOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To use measurements to understand the stress field that resulted in the observed strain and geometries.*
- *To understand the structural evolution of a particular area due to plate tectonics.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the elements of structural geology |
| **CO2:** | Understand the concepts of rock deformation, types of Stress and strain, its use in studying the stages of deformation and factors affecting deformation |
| **CO3:** | Apply the knowledge on brittle and shear failure include fault, lineaments, deep fractures, Joints and Shear zone, tectonites, petrofabrics, foliation and lineation. |
| **CO4:** | Analyze micro, meso and macro structures of various structural features. |
| **CO5:** | Evaluate geologic maps. Analyse the Trigonometric, graphic and stereographic problems. |
| **CO6:** | Create the knowledge on structure and development of earth's crust |

**Course Outline:**

Unit I: Contact Hours: 12

Unit II: Contact Hours: 12

Unit III:Contact Hours: 12

Unit IV: Contact Hours: 12

Unit V: Contact Hours: 12

**UNIT-I**

Introduction to structural geology - GPS and their uses in Geological Mapping – Beds and their attitudes – Dip and Strike – Trends of outcrops – Rotation between true and apparent dips, width of outcrops, True thickness and vertical thickness and their mutual relations.

**UNIT-II**

Mechanical properties of rock: Stress and strain and Types, Stress and strain ellipsoids, Mohr Circle. Physical properties of rocks: deformation, brittleness, plastic and elastic properties. Rock

deformation and stage. Foliation, Types of cleavage, foliation, schistosity, crenulation-orientation of foliation within strain ellipsoid. Lineation-Types and relation to tectonic history.

**UNIT-III**

Geometry and mechanics of folding, minor fold-origin and relation to major structure. Classification and types of folds and mechanics of similar folding. Recognitions of folds in the field. Salt intrusionand salt domes- Unconformities and types – Determination of top and bottom of beds.

**UNIT-IV**

Study of joints - their classification and significances, Faults – Classification – types- Normal, thrust and slip faults. Mechanics of faulting with reference to stress and stress ellipsoids. Recognition of faults in the field classification and geometry of different types of shear zones. Strain variations within shear zone. Origin and significance of different types of minor structures within shear zone. Sense of movement and its determination in shear zones.

**UNIT-V**

Principles and phase of structural analysis. Petro fabrics – field and laboratory technique – tectonics and their symmetry – Application of stereographic projection in the solving of structural problem. Structural analysis of areas of multi-deformation D1, D2 and D3.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| **CO 1** | Remember the elements of structural geology | PO1 | H | PSO1, PSO3 | H | K1 |
| **CO 2** | Understand the concepts of rock deformation, types of Stress and strain, its use in studying the stages of deformation and factors affecting deformation | PO1,PO3 | H | PSO2, PSO4 | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO 3** | Apply the knowledge on brittle and shear failure include fault, lineaments, deep fractures, Joints and Shear zone, tectonites, petrofabrics, foliation and lineation. | PO4, PO5, | M | PSO5, PSO6 | M | K3 |
| **CO 4** | Analyze micro, meso and macro structures of various structural features. | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| **CO 5** | Evaluate geologic maps. Analyse the Trigonometric, graphic and stereographic problems.. | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| **CO 6** | Create the knowledge on structure and development of earth's crust | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1 Badgley.P.C. (1965), Structural and Tectonic Principles, Harper International, New York.

1. Billing, M.P.(1972).Structural Geology, Prentice-Hall.
2. Chiplonkar C.W. & Power K.B., (1988), Geological Maps, Dastane Ramchandra& Co., Pune.
3. Davis,G.H., 1984.Structural Geology of Rocks and Regions. John Wiley & Sons.
4. De Sitter. L.U. (1956), Structural Geology, McGraw Hill, New York
5. Haakon Fossen, 2010. Structural Geology, Cambridge University Press.
6. Hill. E.S. (1972), Elements of Structural Geology, John Wiley, New York
7. Paor, D. (1996). Structural Geology and Personal Computer, Pergamon,
8. Park, R.G., (1983). Foundations of Structural Geology, Blackie & Sons Ltd.
9. Ragan, D M, (1985) Structural geology - An Introduction to Geometrical Techniques, JohnWiley
10. Ramsay.J.G & Huber.M.I, (1983), The Techniques of Modern Structural Geology: Vol I – StrainAnalysis.
11. Ramsay.J.G & Huber.M.I, (1987), The Techniques of Modern Structural Geology:Vol II – Folds& Fractures
12. Rowland, S.M. and Duebendorfer, E.M. (1994). Structural Analysis and Synthesis,Pergamon, W.H. Freeman and Company, New York., p.742
13. Uemura, T., and Mizutani, S., (1979). Geological Structures, Ed. Volume. John Wiley & Sons.
14. Windley, B.F.,(1976).The Evolving Continents. Jhon Wiley and, New York.

## INDIAN STRATIGRAPHY

**Course Code:**

**Course Objectives:**

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

- *To understand the basic principles of stratigraphy, classification, Geologic time scale, nomenclatures.*
- *To understand Major stratigraphic units, stratigraphic correlation, depositional environments, tectono-stratigraphic framework of various stratigraphic units of India and major stratigraphic and extinction boundaries.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the stratigraphic principles and geological time scale |
| **CO2:** | Understand Stratigraphic study of Precambrian, Purana, Cambrian, Permo-carboniferos, Gondwana,Triassic, Jurassic and Cretaceous formations. |
| **CO3:** | Apply the surface and subsurface procedures based on the stratigraphic principles in geological investigations. |
| **CO4:** | Analyze Deccan traps, Siwaliks, Tertiary and Quaternary formations of India; Problems of age. |
| **CO5:** | Evaluate different types of stratigraphic analytical techniques and gain an understanding of boundary problems |
| **CO6:** | Create the knowledge on sequence stratigraphy |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT - I**

Principles of Stratigraphy – Stratigraphic classification and nomenclature – Concept of rock Units- Time units - Lithostratigraphic Units – Biostratigraphic Units – Chronostratigraphic Units – Geological scale – Correlation – Physical and Paleontologic evidences – Homotaxis - Continental evolution during Archaean. Life during Archean, Proterozoic, Palaeozoic, Mesozoic, and Cenozoic.

**UNIT - II**

Correlation of Archaean, Lithology, distribution, tectonics and economic importance of the Precambrian rocks of India. Easter Ghats Province, Central Indian Province– Sargur supergroup – Dharwar Supergroup, Dharwar Province – Sakoli Group – Sausar Group – Iron ore Group of Bihar and Orissa – Bundelkhand Group – Banded Gneiss complex – Aravalli Supergroup.

**UNIT - III**

Cuddapah and Vindhyan groups, Delhi Super group, Kaladgi and Pakhal Groups, Kolhan Group, Bijawar and Gwalior groups. Paleozoic rocks of Spiti, Kashmir and salt range. Paleogeography, Climatic conditions and Coal bearing formations of Gondwana – Triassic of Spiti – Jurassic of Kutch – Trichinopoly Cretaceous – Bagh and Lameta Groups.

**UNIT – IV**

Deccan traps – Classification and age of Eocene, Oligocene and Miocene rocks – Siwalik Supergroup, Karewas of Kashmir – Indo –Gangetic plains – Boundary Problems: Precambrian – Cambrian,Permian – Triassic, Cretaceous – Tertiary. Rise of Himalayas.

**UNIT – V**

Sequence Stratigraphy: Historic perspective – Evolution, Concepts and principles – Relative sea-level, tectonics and Eustasy – Sediment supply – Sequences and System tracts.- Seismic stratigraphy. Recognition of System tracts on seismic data – Outcrop and well data – Sequence stratigraphy of outcrops and cores – Chronostratigraphic charts – Construction of Chronostratigraphic charts from seismic data- Biostratigraphy – Fossil groups and Zonal schemes – Paleoenvironmental analysis – Organic rich facies and system tracts - Hydrocarbon source rocks – Marine carbonates.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the stratigraphic principles and geological time scale | PO1 | H | PSO1, PSO3 | H | K1 |
| CO2 | Understand Stratigraphic study of Precambrian, Purana, Cambrian, Permo-carboniferos, Gondwana, Triassic, Jurassic and Cretaceous formations. | PO1,PO2 | H | PSO2, PSO4 | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Apply the surface and subsurface procedures based on the stratigraphic principles in geological investigations.. | PO4, PO5, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze Deccan traps, Siwaliks, Tertiary and Quaternary formations of India; Problems of age. | PO3, PO5 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate different types of stratigraphic analytical techniques and gain an understanding of boundary problems | PO7, PO6 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create the knowledge on sequence stratigraphy | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Krishnan M.S., (1968). Geology of India and Burma, Higginbothams.
2. Wadia D.N. (1953). Geology of India, McMillian and Co.
3. Ravindra Kumar. (1985). Fundamentals of Historical Geology and Stratigraphy of India.
4. Dunbar, C.O. & Rogers, J. (1961). Principles of Stratigraphy, Wiley.
5. Eicher, L.D. (1968). Geologic time. Prentice Hall.
6. Gignoux, M. (1960). Stratigraphic Geology, Freeman
7. Pasco E.S. (1973). A manual of the Geology of India and Burma.
8. Stokes W.L. (1965). Essentials of Earth History.
9. Weller, M., (1960) Harper & Brothers, New York Stratigraphic Principles and Practice. Harper& Brothers, New York.
10. Dunbar, C.O. and Rogers, J. (1961) Principles of Stratigraphy, Wiley.
11. Stanley, S.M., (1986) Earth and life through time, W.H. Freeman and company.
12. Sarkar, S.N. (1968) Stratigraphy and Geochronology of Peninsular India, Dhanbad Publi.
13. Gupta, V.J. (1977) Precambrian Stratigraphy of India, Hindustan Publishing House.
14. Gupta, V.J. (1976) Cenozoic Stratigraphy of India, Hindustan Publishing House.
15. Lemon R. R, (1990) Principles of Stratigraphy, Merrill publishing company.

## ELECTIVE-1 FIELD GEOLOGY

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Code:**

**Course Objectives:**

- To *learn geological mapping techniques in an area of broad lithological and structural diversity.*
- *To create a geological map and to interpret and discuss the results in a regional tectonic context.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the field equipment, aerial photographs and their use |
| **CO2:** | Understand to Interpret toposheets, remote sensing and other resources for reconnaissance. |
| **CO3:** | Apply the field techniques for various purposes |
| **CO4:** | Analyze data collected from field, tools, survey data and geological reports |
| **CO5:** | Evaluate the rock and mineral specimen in the field, identify the structural features and Measure attitude, thickness, orientations of different features observed in the field |
| **CO6:** | Create contour maps, geological maps and reports |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III: Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Scope of Geological field work; Uses of geological survey; diversity of survey. Orientation of Topographic sheet in field, marking location in toposheet, Bearing (Front and back) Compass and clinometer method of field mapping. Different types of sampling techniques- Field survey equipments: Compass-clinometer, haversack hammer, Chisel, measuring tape; topographic sheet, field diary, Field observations, collecting of specimens; field photographs; degree of accuracy in field work.

**UNIT II**

Geological maps, topographic Maps: Classifications of the features, contours, scale;

directions; Nature of profile section and its construction. Method of field work: survey, mapping laboratory work, writing of field observations, uses of profile section in geological mappings, Procedure in Geological mapping; description of Geological maps. Nature of Legend, requisite data of the completed geological map.

**UNIT III**

Measurement of dip and strike of the rock bed in the field. Effect of topography on outcrop, correlation of outcrops. Field studies of Igneous rocks: flow structure, Pyroclastic rocks, shape of contacts, sharpness of contact. Principal Phenomenon of the contact, Marginal texture contactzones of country rocks, mineralogical and chemical alteration. Field study of structure of Igneous rocks, topographic expression of igneous rock; expression of folds;. Evidence of faulting; faults in relation to their time of origin. Age of joints; Relation of joints to erosion and topography Interpretation of joints. Field identification of metamorphic structures

**UNIT IV**

Interpretation of sedimentary rocks – lithological and time stratigraphic units – Naming and describing sedimentary rocks – beds and related structures – surface between beds – Unconformities. Tops and bottoms of the beds. Measuring stratigraphic sections. Sampling for micro fossils. Surface deposits and related landforms

**UNIT V**

Preparing geological report: Nature of geological report – organization of the report – clarity of the report – index of the report – diagrammatic representation of field data– illustrating of the report –kinds of illustrates – geological mapping and cross section – stratigraphic illustration

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO 1 | Remember the field equipment, aerial photographs and their use | PO1 | H | PSO1, PSO3 | H | K1 |
| CO 2 | Understand to Interpret toposheets, remote sensing and other resources for reconnaissance. | PO1, PO3 | H | PSO2, PSO4 | H | K2 |
| CO | Apply the field techniques for | PO5, PO6, | M | PSO5, | M | K3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | various purposes | | | PSO6 | | |
| CO 4 | Analyze data collected from field, tools, survey data and geological reports | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO 5 | Evaluate the rock and mineral specimen in the field, identify the structural features and Measure attitude, thickness, orientations of different features observed in the field | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO 6 | Create contour maps, geological maps and reports | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Davis, G.R. (1984)., Structural Geology of Rocks and Region, John Wiley
2. H.W. Fairborn,( 1949)., Structural petrology of deformed rocks, John Wiley and sons
3. John Suppe (1985)., Principles of Structural Geology, prentice Hall publications
4. Price N.J., and Cosgrove, J.W. (1990),. Analysis of Geological structures, Cambridge
5. Univ. Press
6. Ramsay, J.G. and Huber,M.I.,( 1987)., Modern structural Geology Vol, I and II
7. Academic press
8. Robert R.Compton, (1962)., Manual of field geology, John Wiley and sons
9. Mathur, S.M., (2001)., Guide to Field Geology, Prentice-Hall of India Pvt. Ltd., New Delhi,
10. Bhattacharyya, A. and Chakraborty, C. (2005) Analysis of Sedimentary Successions: A FieldManual, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
11. McClay, K.R. (2005) The Mapping of Geological Structures, John Wiley & Sons, Chichester,161p.
12. Compton, R.R. (1962) Manual of Field Geology, John Wiley & Sons Inc., 378 p.
13. Barnes, J.W. and Lisle, R.J. (2004) Basic Geological Mapping (Geological Field Guide),
14. JohnWiley & Sons Inc., ISBN- 978-0-470-84986-6, 378 p.

## ELECTIVE-1 CLIMATOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**

- *To understand the concept of climatology and earth radiation balance, behaviour of meteorological parameters concept of EL Nino impact and weather forecasting.*
- *Toto study the climate changes over geological period and its impact.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the interaction between the atmosphere and the earth's surface |
| **CO2:** | Understand the importance of the atmospheric pressure and winds |
| **CO3:** | Apply the atmospheric moisture works |
| **CO4:** | Analyse the cyclones and its impacts. |
| **CO5:** | Evaluate and seasonal and regional climate variations |
| **CO6:** | Create the model of climate and seasonal changes |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT-I**

The Significance and Scope of Climatology, Subfields of Climatology. Introduction, definition, scales, branches and applications of meteorology. Earth Radiation balance: Sun's Energy output, Incoming radiation, Energy spectra of sun and earth, Insulation, Insulation over the globe, insulation losses in atmosphere, long wave radiation, Global radiation balance, Solar energy.

**UNIT II**

Atmosphere, temperature and precipitation : Composition and structure of atmosphere. Atmospheric pressure, circulation , moisture atmospheric pressure factor. Temperature: Introduction, factors influences air temperature, Surface temperature, daily cycle of temperature, annual cycle of temperature, urban heat island. Component of Hydrological cycle - Precipitation: Precipitation processes, orographic precipitation, convection precipitation, frontal type of precipitation.

**UNIT III**

El Nino and weather forecasting : El Nino: Introduction, upwelling. El Nino La Nino events and consequences: unusual weather and rainfall, sea surface temperatures, atmospheric consequences, economic consequence. Detection and prediction of El Nino. Weather forecasting: Persistence, trends, climatology, analog and numerical weather prediction methods. Forecasting surface features: Anti cyclone, cyclone, cold front and warm fronts. Forecasting precipitation: effect of frontal lifting, effect of moisture, rain and snow.

**UNIT IV**

Climate change : Introduction- definition-classification of climate: Koppen's, Bergeron, Thornthwaite's and Strahler classification. Climate change, Palaeoclimatology, Climatic changes through geological time, Geological records of climate, Assessing climate change, Human intervention on climate change. Greenhouse effect, greenhouse gases, Climatic change and global warming, Kyoto protocol.

**UNIT V**

Causes and impact of climate change : Causes of climate change: Astronomical theories, Plate Tectonism, Ocean circulation pattern, Changes in compositions of atmosphere, Changes in solar radiation. Impact of climate change: Climatic factors in plant growth – World patterns of vegetation – Vertical differentiation of vegetation – Climate and forestry – Forest-fire weather – Climate as a factor in soil formation – Spatial patterns of soils – Climate and soil erosion – Marine life – Effects of winds and currents on fisheries. Rising of CO2, impact on atmospheric circulation & weather pattern,biosphere, hydrosphere, sea level changes, Adaptation provinces.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | **PO1 to PO8** | **L/M/H** | **PSO1 to PSO8** | **L/ M/ H** | **$K_1$ to $K_6$** |
| **CO1** | Remember the interaction between the atmosphere and the earth's surface | **PO1** | **H** | **PSO1, PSO3** | **H** | **K1** |
| **CO2** | Understand the importance of the atmospheric pressure and winds | **PO1,PO3** | **H** | **PSO2, PSO4** | **H** | **K2** |
| **CO3** | Apply the atmospheric moisture works | **PO5, PO6,** | **M** | **PSO5,** | **M** | **K3** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | **PSO6** | | |
| **CO4** | Analyse the cyclones and its impacts. | **PO3, PO6** | **M** | **PSO5 , PSO7** | **M** | **K4** |
| **CO5** | Evaluate and seasonal and regional climate variations | **PO7, PO8** | **H** | **PSO7 , PSO6** | **H** | **K5** |
| **CO6** | Create the model of climate and seasonal changes | **PO3, PO8** | **H** | **PSO8** | **H** | **K6** |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. William L. Donn (1975) Meteorology, McGraw –Hill Books Co., New York.
2. Alan .H. Strahler and Arthur N.Strahler (1992) .Modern Physical Geography Fourth EditionsJohn Wiley &Sons.In.p638.,
3. Alan Strahler and Arthur Strahler (2002). Physical Geography, 2nd edition John Wiley & SonsInc.P748.
4. Byers(2005), Meteorology, The Encyclopedia Britannia 15th Ed.
5. Dorothy J.Meeritts and Andrew De (1997) Wet & Kirsten Men king, Environmental Geology –W.H. Freeman and Company, New York ,.,
6. Horace General, (1994) Meteorology New York McGraw Hill.
7. John.M. Das (1995)The Monsoons, National Book house Trust, New Delhi (Third Edition).,
8. Rev.Fr.S. Ignacimuthu (2010) Environmental Studies, MJP Publishers,
9. Travis Hudson (2012) Living with Earth- An Introduction to Environmental Geology, PHILearning Private Ltd,
10. Narora B,(1979). Atmosphere, Weather and Climate: An introduction to Meteorology,Saunders Co., Philadelphia.
11. Horace General, (1994) Meteorology New York McGraw Hill.
12. John.M. Das (1995) The Monsoons, National Book house Trust, New Delhi (Third Edition).,
13. Rev.Fr.S. Ignacimuthu (2010) Environmental Studies, MJP Publishers,
14. Travis Hudson (2012) Living with Earth- An Introduction to Environmental Geology, PHILearning Private Ltd,
15. Alan Strahler and Arthur Strahler (2002). Physical Geography, 2nd edition John Wiley & SonsInc.P748.

## PRACTICAL 1 -DYNAMIC GEOLOGY & GEOMORPHOLOGY AND ADVANCED PALAEONTOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Objectives:**

- To understand the relationship between folding, faulting, volcanic activity, and plate tectonics.
- To evaluate morphological characters of some important invertebrate fossils

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the Process of Endogenic/Exogenic |
| **CO2:** | Understand how geologic structures are a dominant control in the evolution of various landforms |
| **CO3:** | Apply the knowledge on the relationship between folding, faulting, volcanic activity, and plate tectonics. |
| **CO4:** | Analyze landforms illustrated on maps and imagery to geologic processes |
| **CO5:** | Evaluate morphological characters of some important invertebrate fossils |
| **CO6:** | Create the model for various fossils |

**Course Outline: Dynamic Geology and Geomorphology**

*Problems related to*

1. Continental Drift
2. Sea Floor Spreading
3. Plate Tectonics
4. Orogeny
5. Geomagnetism
6. Isostasy
7. volcanism
8. Earthquake- locating Epicenter and Magnitude
9. Intra-conversion of scales of toposheets.
10. Study of contour-variations and elevations on toposheets.
11. Identification and classification of various types of fluvial, aeolian, glacial and volcaniclandforms on toposheets, geological maps, aerial photos and Lansat imageries.
12. Identification, demarcation and classification of folds and faults from the toposheet.
13. Identification, demarcation and classification of lineaments from toposheet.
14. Identification, classification and preparation of drainage basin map on toposheet.

15. Morphometry analysis of the drainage basin on toposheet.
16. Identification and interpretation of gully patterns on toposheet.
17. Preparation of landuse and landcover maps from toposheet.

**ADVANCED PALAEONTOLOGY**

1. Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Pelecypoda, Gastropoda, Ceppalopods, Trilobita, Echinoidea, Corals and Plantfossils.
2. Determination of valves and dental formula of Pelecypoda.
3. Evolutionary study of Trilobites and Ammonites.
4. Identifying invertebrate fossils, drawing neat sketches and labelling its parts.

**Mapping of Cos to POs and PSOs**

| | Course Outcome | PO Addressed | Correlation Level | PSO Addressed | Correlation Level | Cognitive Level |
|---|---|---|---|---|---|---|
| | Remember the Endogenic/exogenic processes. | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| **CO1** | Understand how geologic structures are a dominant control in the evolution of various landforms | PO1 | H | PSO2, PSO3 | H | K1 |
| **CO2** | Apply the knowledge on the relationship between folding, faulting, volcanic activity, and plate tectonics. | PO1,PO3 | H | PSO3, | H | K2 |
| **CO3** | Analyze landforms illustrated on maps and imagery to geologic processes | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| **CO4** | Evaluate morphological characters of some important invertebrate fossils | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| **CO5** | Create the model for various fossils | PO7, PO8 | H | PSO7 | H | K5 |
| **CO6** | Remember the Process that Control Landscapes | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

## PRACTICAL 2 STRACTURAL GEOLOGY AND ELECTIVE-1

**Course code:**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Objectives:**

- To gain knowledge on field measurements of attitude of rocks and to impart geological mapping techniques and to determine bed thickness and depth.
- To learn lithostratigraphic maps of India showing distribution of important geological formations
- To learn the distribution of major climatic regimes of India and Numerical exercises on interpretation of proxy records for Paleoclimate.

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the contour map analysis. |
| **CO2:** | Understand to recognize different faults and fold types, ability to use clinometers/ Brunton compass, |
| **CO3:** | Apply the knowledge on structural problems based on dip and strike, besides preparing cross sections from basic geologic maps |
| **CO4:** | Analyze toposheets, geological maps and mine plans and profile studies using various technology |
| **CO5:** | Evaluate the distribution of major climatic regimes of India and Numerical exercises on interpretation of proxy records for Paleoclimate. |
| **CO6:** | Create lithostratigraphic maps of India showing distribution of important geological formations. |

**Course Outline:**

**STRUCTURAL GEOLOGY**

1. Preparation of topomap, calculation of slope; drawing a profile.
2. Determination of strike and dip; Strike-whole-circle bearing and quadrant systems.
3. Representation of planar structures through strike and dip.
4. Representation of linear structures through strike and pitch.
5. Measurement of strike and dip using compass clinometer &Brunton compass in the field.
6. Problems involving true and apparent dip, true vertical thickness and width of outcrops.
7. Geological map Interpretation: Lithological and Structural maps: 3-point problem, fold, fault and unconformity.
8. Drawing profile sections for geological maps of different complexities.

**STRATIGRAPHY**

**Problems related to** : Rate of sedimentation, Rate of rock uplift Time of sedimentation, Relative

dating problems, Stratigraphic sequences from geological sections, Stratigraphy of a geological section- fossils and radiometric age.

**Preparation of Maps**: Interpretation of a geological map, Boundary problem, Preparation of the geological time scale, Rock formation of India in the geological time scale, History of life through the geological ages, Evolution of man, Draw the tectonic map of India with reference to geological timescale, Mark the major proterozoic super group of peninsula India on the map, Mark the map showing physiographic divisions of India, Mark the map showing major ranges of the map, Point on the map, the stratigraphic oil formation on the map of India, Mark the coal stratigraphic formation on the map of India, Mark the map of peninsula India showing major cratons and mobile belts, Mark the mbf and siwalik system on the map, Delineate the Gondwana formation on the map

**FIELD GEOLOGY**

Reading of toposheets, geological maps and mine plans, Representation factor of scale, presentationof scale on the maps. Field forward and backward bearing, Profiling using Abny's level and Levelling using Dumpy's level, Operation of GPS.

**CLIMATOLOGY**

Study of distribution of major climatic regimes of India on map, Distribution of major wind patterns on World map, Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals. Numerical exercises on interpretation of proxy records for Paleoclimate.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the contour map analysis. | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand to recognize different faults and fold types, ability to use clinometers/ Brunton compass, | PO1,PO3 | H | PSO3, | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Apply the knowledge on structural problems based on dip and strike, besides preparing cross sections from basic geologic maps | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze toposheets, geological maps and mine plans and profile studies using various technology | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluate the distribution of major climatic regimes of India and Numerical exercises on interpretation of proxy records for Paleoclimate. | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create lithostratigraphic maps of India showing distribution of important geological formations. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

## MINERAL SCIENCES

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Code:**
**Course Objectives:**

- *To learn the basic principles behind the arrangement of atoms to form crystal structures, how these atoms are coordinated and bonded and how this is reflected in the external form, chemical composition, and physical properties of the crystals.*
- *To learn how to identify the most common minerals in hand specimen and, by using optical techniques, learn how to identify the common minerals in thin section.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the crystal properties and properties of minerals |
| **CO2:** | Understand the Repetition and Translation periodicity of crystals and derivation of 32 crystal classes. Understand and analyse Stereographic Crystal projection. |
| **CO3:** | Apply diagnostic and advanced optical properties of common rock forming minerals |
| **CO4:** | Analyze mineral chemistry and the advanced instrumental analytical techniques used for minerals |
| **CO5:** | Evaluate industrial applications and economic importance of various minerals. |
| **CO6:** | Create report on a mineral sample by performing the necessary tests and suggest its applications in various fields. |

**Course Outline:**

Unit I: Contact Hours: 12

Unit II: Contact Hours: 12

Unit III:Contact Hours: 12

Unit IV: Contact Hours: 12

Unit V: Contact Hours: 12

**UNIT-I**

Crystal Properties: Definition-parts of crystal- Interfacial angle and their measurements- representation of crystal faces: Crystal Parameter, Parameter System of Weiss, Index System of Miller . Crystal Forms- Laws of Crystallography: Law of Constancy of Interfacial Angles, Law of Rational Indices, Law of Axial Ratio. Crystallographic Axes and Axial Ratios- Elements of Symmetry - 14 Bravies space lattices- Crystal Systems: Classification of Crystal Systems- Classification of Crystals into 7 Systems.

***UNIT-II***

Derivation of 32 crystal classes of symmetry - Projections – Stereographic and Gnomonic projections of crystals belongs to normal classes. Calculation of crystal elements making use of

tangent relation. Principles of X-ray diffraction – the Bragg's law. Principles and methods of X-ray powder diffraction. Twinning in crystals.

***UNIT-III***

Atomic structures – Chemical bonds- importance of ionic size—coordination number-Pauling's rule - structural classification of silicate minerals – Isomorphism – solid solution- Atomic substitution - Exsolution- Order & Disorder & Disorder relation- Polymorphism Pseudomorphism - Fluorescence in minerals, metamict stage- Staining techniques.

***UNIT-IV***

Description of chemical, Optical and physical properties of distinguishing features and paragenesis of the following: *Ortho & Ring silicates* –Olivine group, Garnet group, Alumino-silicates- *Chain Silicates*: Pyroxene group, Amphibole group-*Sheet silicate*: Mica group, Clay minerals-*Framework Silicate*: Feldspar group , Quartz group and Zeolite group.

***UNIT-V***

Properties of light: reflection, refraction, dispersion, and refractive indices. Refractometry: Relief, determination of RI by immersion method, Becke line method/central illumination method, Oblique illumination method. Optical Crystallography: Isotropic, Uniaxial , biaxial and concept of indicatrix Optical properties of Anisotropic minerals: - absorption of light, Pleochroism, determination of Pleochroic scheme- Birefringence- determination of birefringence from colour chart- Interference and interference colour- determining different orders of interference colours – Extinction anddetermination of extinction angle. Uses of accessory plates –sign of elongation-Optic sign and optic sign determination- optical properties of Uniaxial minerals and biaxial minerals.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO 1 | Remember the crystal properties and properties of minerals | PO1 | H | PSO1, PSO2 | H | K1 |
| CO 2 | Understand the Repetition and Translation periodicity of crystals and derivation of 32 crystal classes. Understand and analyse Stereographic Crystal | PO1,PO3 | H | PSO3, PSO4 | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | projection. | | | | | |
| CO 3 | Apply diagnostic and advanced optical properties of common rock forming minerals | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO 4 | Analyze mineral chemistry and the advanced instrumental analytical techniques used for minerals | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO 5 | Evaluate industrial applications and economic importance of various minerals. | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO 6 | Create report on a mineral sample by performing the necessary tests and suggest its applications in various fields. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. De Jong,W.F.,(1955), General crystallography, Freeman.
2. Flint, F. (1964): Essentials of Crystallography, Peace Pub., Russia.
3. Joseph .V.Smith., (1982), Geometrical and structural crystallography. John Wiley& sons.
4. Deer, W. A., Howie, R. A. & Zussman, J. (1996): The Rock Forming Minerals, Longman
5. Berry Mason, (2004), Mineralogy, CBS Publishers, New Delhi.
6. Phillips, W. R. and Griffen, D. T. (1986): Optical Mineralogy. CBS Publishers.
7. Ford W. E., (2006) Dana's Text Book of Mineralogy CBS Pub. & Dist., New Delhi
8. Kerr, P.F. 1959. Optical Mineralogy, McGraw-Hill Book Company, Inc.
9. Winchell, A.N.1962. Elements of Optical Mineralogy, John Wiley.
10. Babu, S. K. (1987): Practical Manual of Crystal Optics, CBS Publishers.
11. Berry L.G. and Brain Mason. 1968.Mineralogy. W. H. Freeman and Company, San Francisco.
12. Naidu., P.R.J.1941.Text Book of Mineralogy.
13. Read, H.H. (1962).,Rutley's Elements of Mineralogy Reprint CBS Pub. & Dist., New Delhi.
14. Hutchison, C.S., (1974), laboratory handbook of Petrographic Techniques. John Wiley.
15. Hans-RudoltWenk and Andrei Bulakh.,(2004), Minerals – Their constitution and origin.Cambridge University Press.

## MARINE GEOSCIENCES

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *The primary objective of this course is to learn about the origin, structure and evolution of the ocean basins and their margins.*
- *This course also aims to teach the chemical, physical and geological process active in ocean and management of coastal environments in terms of pollution and natural hazards*.

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the marine landforms |
| **CO2:** | Understand the development of landforms through Earth's external processes by various geological agents; marine processes and formation of marine landforms. |
| **CO3:** | Apply the marine survey methods to understand ocean character. Application of international coastal regulations |
| **CO4:** | Analyze the waves, tides and tides and its impact. Analyse and study Marine Pollution |
| **CO5:** | Evaluate the physical and chemical properties of marine water and marine sequence stratigraphy |
| **CO6:** | Create seafloor morphological and bathymetric report |

**Course Outline:**

Unit I: Contact Hours: 12

Unit II: Contact Hours: 12

Unit III:Contact Hours: 12

Unit IV: Contact Hours: 12

Unit V: Contact Hours: 12

**UNIT-I**

Ocean Basins: History of Marine Geology – Marine Geology research vessels of India –Evolution of Ocean Floor: active and passive continental margin. Ocean floor morphology: Description of Continental shelf, slope, rise and abyssal plains. Features of deep ocean basin- Mid-oceanic ridge, Subduction zone , trenches, Island arcs, Hot spots, Transform faults and Triple junction. Plate tectonics and Neotectonic processes. Formation of oceanic crust-destruction of oceanic lithosphere.

**UNIT-II**

Equipment's and Deposition: Principles of Echo sounder, Side scan sonar, underwater cameras and bottom samplers - Position fixing at Sea. Marine sedimentation: Sources and distribution of sediments – Transport of sea bottom sediment - Rate of deposition. Mineral resources of the oceans and the factors controlling their distribution. Stratigraphy and geochronometry of deep-sea deposit: phosphorite, glauconites, barium sulphate concretions, Polymetallic nodules. Beach placers.

**UNIT-III**

Physical oceanography: Temperature – Mixing processes in oceans – Important water masses – Waves and their characteristics – Principles of wave forecasting – Tides and their causes – Prediction of tides by the Harmonic method – Tidal currents in shallow seas, estuaries and rivers . Types and effects ocean circulation and currents. Beach stability – beach nourishment.

**UNIT IV**

Chemical oceanography: Composition of sea water – Classification of elements – Major and minor constituents – Behavior of elements – Chemical exchanges in sea water – Chemical and biological interactions – Ionic interactions –important biogenic dissolved gases – Carbon dioxide-carbonate system – Alkalinity and control of pH – Abiotic and biotic controls of trace elements in the oceans – Biogeochemical processes in aerobic and anerobic environments – Water column denitrification and emission of greenhouse gases.

**UNIT-V**

Marine Environment: Human and ocean – marine pollution: types and effects-Measures to control coastal erosion - Evolution of Coral reefs and its distribution along Indian Coast. Law of the Sea Treaty: Introduction, UNCLOS -I, II and III. LOS Treaty – demarcation of various zones (Territorial Sea, Contiguous Zone, Exclusive Economic Zone, Legal Continental Shelf, High Sea, International Area of the Seabed), rights of coastal nations. International Seabed Authority. Coastal zone regulations inIndia.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the marine landforms | PO1 | H | PSO1, PSO2 | H | K1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | Understand the development of landforms through Earth's external processes by various geological agents; marine processes and formation of marine landforms. | PO1,PO2 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply the marine survey methods to understand ocean character. Application of international coastal regulations | PO3, PO4, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze the waves, tides and tides and its impact. Analyse and study Marine Pollution | PO5, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate the physical and chemical properties of marine water and marine sequence stratigraphy | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create seafloor morphological and bathymetric report | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Shephard, F.P., (1973). Submarine Geology, Harper and Row.
2. Kurekian, K.K., (1990). Ocean, Prentice Hall.
3. Seabold, E. and Berger,W.H. , (1982). The Sea Floor, Springer Verlag.
4. Kuenen, Ph.H.,(1950). Marine Geology. John Wiley and Sons.
5. King, C.A.M., (1959). Beaches and coasts, Edward Arnold, London.
6. King, C.A.M., (1975). Introduction to marine Geology and Geomorphology. Edward Arnold,London.
7. Radhakrishnan, V., (1996). General Geology V.V.P. Publishers, Tuticorin.
8. Shepard, F.P., (1978). Geological Oceanography, Heinmann, London.
9. Harper and Row. Kurekian, K.K., 1990. Ocean, Prentice Hall. New Jersey.
10. Svedrup, J.F., (1969). The Ocean, A Scientific American book, W.H. Freeman

and company,San Francisco.
11. Kennett,J.P. (1982). Marine Geology. Prentice Hall. New Jersey.
12. Weisberg,C.P. (1979). Oceanography. McGraw Hill. New York.
13. Kennett, J.P. (1982) Marine Geology. Prentice Hall, London.
14. Pipkin, B.W., Gorsline, D.S., Cassey, R.E. and Hammond, D.E. (1972) Laboratory ExercisesinOceanography. W.H.Freeman& Co., New York.
15. Tom Garrison (2009)Essentials of Oceanography. Brooks/Cole, Cengage Learning, USA

## ADVANCED HYDROGEOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

*To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth and to get theoretical, practical and field knowledge pertaining to Hydrogeological domain, physical, chemical and biological characteristics of water with special emphasis on pollution and contamination.*

*To able to gain knowledge on rock-water interaction and salt water intrusion and its remedial measures in the coastal aquifers. Students also get the ability to ethical, social, health and sustainable consumption of water resources.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the origin, occurrence, distribution and movement of groundwater in relation to hydrological cycle and aquifers. |
| **CO2:** | Understand the aquifer properties, and types of aquifers, vertical distribution of water in aquifers, and the application of radioisotopes in hydrogeology.. |
| **CO3:** | Apply various methods of groundwater exploration and prospecting with special emphasis on geo-electrical – electrical resistivity method; describe the methods of drilling for groundwater and explain water well construction and maintenance of production wells. |
| **CO4:** | Analyze groundwater hydraulics with reference to Darcy's law, aquifer parameters and describe the procedures of pumping test and data analysis for determination and quantification of aquifer parameters |
| **CO5:** | Evaluate groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution |
| **CO6:** | Create concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III: Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Hydrogeological cycle, ground water in Hydrogeological cycle, Origin and occurrence of ground water, vertical distribution of ground water – geological formations of aquifers – structural and stratigraphical control on occurrence and movement of ground water.

Type of Aquifers - Hydrologic properties of aquifers – porosity, void ratio, permeability, Transmissivity, Storativity, Specific Yield, Diffusivity.

**UNIT II**

Ground water movement and tracing techniques – hydraulics of ground water movement – Darcy's principle – flow of ground water and flow equations for confined aquifers under steady and unsteady flow conditions – pumping test and determination of aquifer characterises using pump test data – Theis's method, Jacob's method and Chow's method. Types of well and methods of well construction – dugwells – bore wells – infiltration galleries and collector wells and tunnels. Drilling techniques: design, development and completion of bore well and types of pumps.

**UNIT III**

Groundwater exploration techniques: electrical resistivity method and seismic method. Test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration. Groundwater budget estimation – Groundwater models and their role in water management– Graphical representation of hydrochemical data.

**UNIT IV**

Ground water recharge, interaction between surface and ground water – natural recharge conditions, factors affecting recharges – conjunctive use of surface and ground water. Surface and sub-surface artificial recharge methods. Groundwater development and management, problems of over-exploitation of groundwater; water management in rural and urban areas. Rain water harvesting, Principles of management of water resources, groundwater problems and their management in India. Submarine Groundwater Discharge (SGD) and determination methods.

**UNIT V**

Water Pollution, types of pollution, controlling methods; water purification: settling, coagulation, fluorination, defluorination, disinfection, deodorization. Sources of elevated concentration of salts, Chemical characteristics of groundwater in relation to domestic industrial and irrigational uses. Saltwater encroachment in coastal aquifers. Groundwater basins of Tamil Nadu.

**Mapping of Cos to POs and PSOs**

| | Course Outcome | PO Addressed | Correlation Level | PSO Addressed | Correlation Level | Cognitive Level |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the origin, occurrence, distribution and movement of groundwater in relation to hydrological cycle and aquifers. | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand the aquifer properties, and types of aquifers, vertical distribution of water in aquifers, and the application of radioisotopes in hydrogeology.. | PO1,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply various methods of groundwater exploration and prospecting with special emphasis on geo-electrical – electrical resistivity method; describe the methods of drilling for groundwater and explain water well construction and maintenance of production wells. | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze groundwater hydraulics with reference to Darcy's law, aquifer parameters and describe the procedures of pumping test and data analysis for determination and quantification of aquifer parameters | PO3, PO6 | M | PSO5, PSO7 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO5 | Evaluate groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Bouwer, H (1978). Groundwater Hydrology.
2. Davis, S.N. and Dewiest, R.J.N (1966). Hydrogeology, John Wiley and Sons Inc. New York.
3. Hiscock K (2005) Hydrogeology, Principle & Practice, Blackwell publishing.
4. Krisch R (2006) Groundwater geophysics, Springer - Verlag
5. Linsley, R. K., Kohler, M. A. and Taulhus, J. L. H (1975). Applied Hydrology, Tata McGraw Hill.
6. Walton, W. C (91970). Groundwater Resource Evaluation, McGraw Hill Inc.
7. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
8. Fetter, C.W., (1990), Applied Hydrogeology-McGraw Hill, Publisher, New Delhi.
9. Freeze, R.A. and John,A., (1979), Groundwater, Cherry, Prentice Hall,Inc,604p.
10. Handa.O.P (1984), Groundwater Drilling, Oxford & I.B.H. Publishing Co.
11. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-TataMcGraw Hill New Delhi 720p.
12. Kazmann, (1973), Modern Hydrology, Harper and sons Publishers, New Delhi.
13. Manning,J.C.,(2007),Applied Principles of Hydrology, CBS Publishers and Distributers ,NewDelhi.
14. Todd D.K., (1980). Groundwater Hydrology, John Wiley.
15. Walton V.C. (1970). Groundwater Resource Evaluation. McGraw Hill Book Co., New York.

## ELECTIVE-2 ADVANCED REMOTE SENSING AND GIS

| | | | | |
|---|---|---|---|---|
| **C** | | | | |
| **C** | | | | |

- This course provides background knowledge and understanding of principles Remote sensing and to do visual interpretation and digital image processing for remote sensing data analysis.
- To gain advance knowledge in spatial data understanding, analysis and programming skill in GIS environment. Students will also be exposed to advance analytical and modelling techniques.

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the origin, occurrence, distribution and movement of groundwater in relation to hydrological cycle and aquifers. |
| **CO2:** | Understand the aquifer properties, and types of aquifers, vertical distribution of water in aquifers, and the application of radioisotopes in hydrogeology.. |
| **CO3:** | Apply various methods of groundwater exploration and prospecting with special emphasis on geo-electrical – electrical resistivity method; describe the methods of drilling for groundwater and explain water well construction and maintenance of production wells. |
| **CO4:** | Analyze groundwater hydraulics with reference to Darcy's law, aquifer parameters and describe the procedures of pumping test and data analysis for determination and quantification of aquifer parameters |
| **CO5:** | Evaluate groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution |
| **CO6:** | Create concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III: Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Remote sensing: Basic concepts and principles of remote sensing - Electromagnetic Radiation and its Properties- EMR and Atmosphere Interaction - Energy-Earth Interaction - Spectral Signature: Vegetation, Soil, Water, Minerals and Rocks. Remote Sensing Platforms- Types of Satellites- Orbits and their Types- Sensor Systems- Image Resolution and its Types. Resolution in Microwave

Remote Sensing - Relationship between different types of resolution.

**UNIT II**

Indian Space Programme: Indian Remote Sensing Satellite Series, Radar Imaging Satellite Series, Indian National Satellite Series - Global Space Programs- Commercial Remote Sensing Satellites. Visual Interpretation- Elements of Visual Image Interpretation.

**UNIT III**

Digital Image Processing- Steps in Digital Image Processing- Types and Characteristics of Digital Images- Advantages of Digital Image Processing- Concept of True and False Colour Composite- Imagehistogram and its significance - Image corrections: Radiometric and Geometric correction- Image Enhancement techniques- Image Classification : Unsupervised and supervised classification.

**UNIT IV**

Introduction to GIS - Coordinate systems: Geographic coordinate system, datum and map projection and its types, projected coordinate systems. Spatial data types: Spatial data: vector data and its model, Topology and its importance- TIN – Raster data – elements of raster data model: cell value, size and depth – raster bands – raster data structure – Digital Elevation Model and its importance. Nonspatial data. Fundamental concepts of GPS and its application in Geology.

**UNIT V**

Vector data analysis: Buffering and application of buffering, Proximity analysis, Overlaying and application of overlaying, Pattern analysis and its application. Raster data analysis: Local operations- Neighborhood Operations –Network analysis. Surface Modelling: raster, TIN, terrain datasets and LAS data sets- Application of GIS in geological mapping, groundwater exploration, artificial groundwater recharge and natural resource management. Data Output and Display .

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the origin, occurrence, distribution and movement of groundwater in relation to hydrological cycle and aquifers. | PO1 | H | PSO1, PSO2 | H | K1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | Understand the aquifer properties, and types of aquifers, vertical distribution of water in aquifers, and the application of radioisotopes in hydrogeology.. | PO1,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply various methods of groundwater exploration and prospecting with special emphasis on geo-electrical – electrical resistivity method; describe the methods of drilling for groundwater and explain water well construction and maintenance of production wells. | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze groundwater hydraulics with reference to Darcy's law, aquifer parameters and describe the procedures of pumping test and data analysis for determination and quantification of aquifer parameters | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate groundwater quality studies related to well inventory, collection and analysis of water samples and interpretations of water quality for domestic and agricultural purposes based on standard graphs and diagrams like Hill-Piper Trilinear diagram and U.S. Salinity diagram; and to understand groundwater contamination and pollution | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create concepts and methods of groundwater recharge, problems related to over-exploitation of groundwater, groundwater legislation; and groundwater provinces | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Campbell, J.B.2002: Introduction to Remote Sensing. Taylor Publications
2. Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin
3. LRA Narayan(2012). Remote Sensing and its Applications., University Press
4. Jensen, J.R. 2000: Remote Sensing of the Environment: An Earth Resource Perspective.Prentice Hall.
5. Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, JohnWiley.
6. Anji Reddy, M. 2004: Geoinformatics for Environmental Management. B.S. Publications.
7. Chang, Kang-Tsung, (2019) Introduction to Geographic Information Systems., McGraw-HillEducation.
8. Heywood.I, Cornelius S, Curve Steve. 2003: An Introduction to Geographical InformationSystems. Pearson Education.
9. Ram Mohan Rao. 2002: Geographical Information Systems. Rawat Publication.
10. Narayan Panigrahi (2008). Geographical Information Science., University Press, Hyderabad.
11. Chandra A.M & S.K. Ghosh (2006), Remote Sensing & Geographical Information System,Narosa Publishing House, Chennai.
12. Curran,B (1985): Principles of Remote Sensing, Longman, London. Inc.
13. Gupta, R.P. (2000) Remote Sensing Geology. Springer-Verlag. 356pp.
14. Sabins,F.F.Jr (1978):Remote sensing Principles and Interpretation, Freeman, Sanfrancisco, New York.
15. Shiv.N.Pandey (1987),Principles & Applications of Photo geology, Wiley Eastern ltd.

## ELECTIVE-2 ISOTOPE GEOLOGY

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Code:**
**Course Objectives:**

- *To understand the mechanisms of distribution (stable isotopes) and evolution (radiogenic isotopes) of isotope composition in natural materials.*
- *This course will make students able to analyze and conclude the geological history of Earth and rock systems through current isotopic and geochemical signatures.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the basic fundamentals of earth and it s chemical components |
| **CO2:** | Understand the radiogenic isotope geochemistry |
| **CO3:** | Apply the concepts of isotopes in geochronology |
| **CO4:** | Analyze stable isotopes in geological studies |
| **CO5:** | Evaluate stable isotopes and their application for paleoclimate studies |
| **CO6:** | Create concepts and methods of the role of isotopes in geological exploration |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III: Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT-I**

Introduction to Isotope Geology: Introduction – Basic principles of Isotope Geology– Isotopy - Chemical properties of Isotopes, Thermodynamic properties of Isotopic compounds -Equilibrium constants, separation of isotopes - Physical and chemical methods -Classification of Isotopes - Relationship between radionuclides and its decay products, Units of radioactivity measurement.

**UNIT-II**

Distribution and properties of Isotopes: Distribution of Radioactive elements in Igneous, Sedimentary and Metamorphic rocks and waters - Study of important unstable isotopes. Distribution of Radioactive mineral deposits in India - Geochemical behaviour of Uranium and Thorium – Natural production - Anthropogenic releases of radionuclides.

**UNIT-III**

Instrumentation and methods of application of radioactive isotopes: Measurement of

radioactivity- Scintillation counters, Mass spectrometer. Isotopic dilution techniques. Geochronometry, Age of the earth, Age of the element, rate and age of deposition, radioactivity and genesis of petroleum. Use of radioactivity in Well logging. Application of environmental isotopes. Fractionation of stable isotopes in lithosphere, Hydrosphere and Atmosphere. Stable isotopes and their uses.

**UNIT-IV**

Stable isotopes and its nature: Stable isotopes in water cycle - Relation between18O/16O and 2H/1H in natural waters –Evaporation, Clouds and Precipitation - marine and continental atmosphere. Isotope effects in precipitation - The latitude / annual temperature effect - Seasonal effect - Oceanic and continental precipitation - Altitude effect – Amount effect - Interannual variations - Small-scale variations - Palaeoclimate reconstruction. Tritiumin the atmosphere - Characteristics of tritium - Geophysical aspects - Hydrological aspects. Atmospheric CO2 - Atmospheric CO2 concentrations - Stable carbon isotopes in atmosphericCO2 - Stable oxygen isotopes in atmospheric CO2 - Radiocarbon in atmospheric CO2. Water Sampling and Treatment - Water sampling and storage - Laboratory treatment of water samples - 18O/16O analysis - 2H/1H analysis - 3H analysis of water - 14C analysis of dissolved inorganic carbon - 13C/12C analysis of dissolved inorganic carbon.

**UNIT-V**

Tracer techniques in hydrogeology: Tracers and transports - Types of tracers -Types of tracer experiments – Isotopic tracers. Water Rock Interaction - physical absorption -Chemical absorption - Exchange of ions - Chemical interaction between solutes. Low Temperature System - Unsaturated zone - Geohydraulic aspects - Solute transport–Applications - Saturated zone- Origin of groundwater- Groundwater dating -The radiocarbon dating - 14C standard - natural 14C variations - 14C age determination - Dating groundwater with DIC and DOC - Relation between 13C and 14C variations - Comparison of 3H and 14Cvariations. High Temperature Systems - Natural processes - Anthropogenic processes

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the basic fundamentals of earth and it s chemical components | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand the radiogenic isotope geochemistry | PO1,PO3 | H | PSO3, PSO4 | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Apply the concepts of isotopes in geochronology | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze stable isotopes in geological studies | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate stable isotopes and their application for paleoclimate studies | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create concepts and methods of the role of isotopes in geological exploration | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand,

$K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Henry Faul, (1954). Nuclear Geology, John Wiley & Sons, New York,
2. KalveroRankama, (1954). Progress in Isotope Geology, Pergamon press, London.
3. Gaunter Faure,(1986). Principles of Isotope Geology, John Wiley & Sons, New York,2nd ed.
4. Aswathnarayana, U. (1985). Principles of Nuclear Geology, Oxonian Press(P) Ltd.,New Delhi.
5. Rankama and Sahama, (1950). Geochemistry, University of Chicago Press,.
6. Robert D. Nininger, D. (1955). Minerals of Atomic energy, Van Nostrand Co.,
7. Zussman. J, Longmans, (1966). Physical methods in Determinative mineralogy.
8. Virnave, S.N., (1999), Nuclear Geology and Atomic Mineral Resources, BharatiBhawanPublishers & Distributors.
9. Mason, B. and Moore, C.B. (1985) Principles of geochemistry, Wiley Eastern Ltd, Bangalore
10. 2. Faure G. (1986) Principles of isotope geology1, John Wiley & Sons
11. 3. Faure, G., Mensing, T. M., Tsotopes – Principles and Applications, Wiley India Pvt. Ltd.,New Delhi
12. 4. Krauskopf, E.B. (1979) Introduction to geochemistry, McGraw Hill Book Company, NewDelhi.
13. 5. Gill, R. (1989) Chemical fundamentals of geology, Unwin Hyman, London
14. 6. Albarede F. (2003) Geochemistry- An introduction, Cambridge university press.
15. 7. Dickin, A.P. Radiogenic isotope geology. Cambridge University Press.

## ELECTIVE-2 URBAN GEOLOGY

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Code:**
**Course Objectives:**

- *The objectives this course is to enhance the knowledge to protect the environment, improve public health and safety, and increase the wealth of choices.*
- *To understand the concepts of GIS in Urban Geology*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the basic fundamentals of geomorphology |
| **CO2:** | Understand the geohazards or disaster for the establishment of the intelligent monitoring and predictive evaluation techniques; |
| **CO3:** | Apply the concepts complex geological disaster vulnerability; |
| **CO4:** | Analyze responsive technology for long-term changes in urban coastal and river |
| **CO5:** | Evaluate the land use techniques for various geological aspects and civil projects |
| **CO6:** | Create concepts and methods GIS in urban geology |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Geology and Society, Necessity of Geology in Urban life. Geology in Urban Constructions, Geotechnical feature and mapping for subsurface in Metropolitan areas, Building materials, Excavation and cutting in urban areas.

**UNIT II**

Geology and Urban Agriculture, Soil studies, Chemistry and geochemistry of soil in relation to groundwater and fertilizer Effect of pollutants on agricultural land.

**Unit III**

Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban landuse, Geological problems in construction of underground structures in urban areas. Urban Tunnelling: Tunnelling for road and rail in urban areas, Method, Equipments, Important Geological parameters.

**Unit IV**

Urban water: Water lagging in built-up areas, Source of water, Standards for various uses of water. Sources of contamination, Ground water surveys and resource development. Urban wastes and Treatment, Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Mine drainage, Power production waste, Radioactive waste, mapping for selection of waste disposal sites.

**UNIT V**

GIS in Urban Geology: GIS-An introduction, Application in Urban development, Application in landuse, Application in groundwater. Precaution from seismic hazard in Urban planning Micro-zonation mapping for hazard

**UNIT-V**

Tracer techniques in hydrogeology: Tracers and transports - Types of tracers -Types of tracer experiments – Isotopic tracers. Water Rock Interaction - physical absorption -Chemical absorption - Exchange of ions - Chemical interaction between solutes. Low Temperature System - Unsaturated zone - Geohydraulic aspects - Solute transport–Applications - Saturated zone- Origin of groundwater

- Groundwater dating -The radiocarbon dating - 14C standard - natural 14C variations - 14C age determination - Dating groundwater with DIC and DOC - Relation between 13C and 14C variations - Comparison of 3H and 14Cvariations. High Temperature Systems - Natural processes - Anthropogenic processes

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the basic fundamentals of geomorphology | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand the geohazards or disaster for the establishment of the intelligent monitoring and predictive evaluation techniques; | PO1, PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply the concepts complex geological disaster vulnerability; | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze responsive technology for long-term changes in urban coastal and river | PO3, PO6 | M | PSO5, PSO7 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO5 | Evaluate the land use techniques for various geological aspects and civil projects | PO7, PO8 | H | PSO7, PSO6 | H | K5 |
| CO6 | Create concepts and methods GIS in urban geology | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Huggenberger, P. and Eptin, J.( 2011) Urban Geology: Process-Oriented Concepts forAdaptive and Integrated Resource Management. Springer
2. Lollino, G. et al. (2015), Engineering Geology for Society and Territory. Springer.
3. Peter Huggenberger and JannisEpting (2011) Urban Geology: Process-Oriented Concepts forAdaptive and Integrated Resource Management. Springer.
4. Daniel T. Rogers, (2020) Urban Watersheds Geology Contamination EnvironmentalRegulations And Sustainability. Taylor and Francis.
5. Mary J. Thornbush and Casey D. Allen (2018) Urban Geomorphology: Landforms andProcesses in Cities. Elsevier Science.
6. P. Willems, J. Olsson, K. Arnbjerg-Nielsen, S. Beecham, A. Pathirana, I. B. Gregersen, H.Madsen, V.-T.-V. Nguyen ( 2012) Impacts of Climate Change on Rainfall Extremes andUrban Drainage Systems. IWA Publishing, UK.
7. M. G. Mansell (2003) Rural and urban hydrology, ICE Publishing.
8. Martin van Maarseveen, Javier Martinez and Johannes Flacke (2019) GIS in SustainableUrban Planning and Management : A Global Perspective. CRC Press.
9. John Randolp (2003) Environmental Land Use Planning and Management., Island Press.
10. Timothy L. Nyerges, PiotrJankowski,StanGeertman, Helen Couclelis and JacekMalczewski(2010) Regional and Urban GIS : A Decision Support Approach. CRC Press

## PRACTICAL 3 MINERAL SCIENCES AND MARINE GEOSCIENCES

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Code:**

**Course Objectives:**

- *To understand the crystal system and identify the minerals microscopy and megascopy.*
- *To understand beach profile study and seawater chemistry.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember to Identify the minerals in hand specimens |
| CO2: | Understand the symmetry elements of normal class of all crystal systems and draw certain simple and combination crystal forms, found in these classes of all crystal systems. |
| CO3: | Apply basic study to recognizing and describing certain common minerals on the basis of their diagnostic physical properties, use of petrological polarizing microscope and study of optical properties of common rock forming minerals |
| CO4: | Analyze physical and chemical properties of marine water |
| CO5: | Evaluate Beach profile survey. |
| CO6: | Create bathymetry maps<br>. |

**Course Outline:**

***MINERAL SCIENCES***

a. Study of rock- forming minerals in hand specimen
b. study of rock- forming minerals in thin sections
c. Determination of pleochric scheme
d. Determination of extinction and extinction angle,
e. Determination of interference colours
f. anorthite content of plagioclases
g. Location of fundamental poles on stereographic projections
h. Location of faces
i. Determination of zones and zonal symbol
j. Determination of axial ratio using tangent relations.
k. Determination of inter-polar distances in Isometric, Tetragonal, Orthorhombic and Hexagonalsystems using Equation of Normal.

***2. MARINE SCIENCES***

a. Beach profile survey.
b. Estimation of salinity of seawater

c. Determination of dissolved oxygen of seawater
d. Determination of pH of seawater
e. Study of bathymetry maps
f. Study of marine seismic profiles.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/ H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember to Identify the minerals in hand specimens | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the symmetry elements of normal class of all crystal systems and draw certain simple and combination crystal forms, found in these classes of all crystal systems. | PO1,PO 3 | H | PSO3, | H | K2 |
| CO3 | Apply basic study to recognizing and describing certain common minerals on the basis of their diagnostic physical properties, use of petrological polarizing microscope and study of optical properties of common rock forming minerals | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze physical and chemical properties of marine water | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluate Beach profile survey. | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create bathymetry maps . | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

## PRACTICAL 4 ADVANCED HYDROGEOLOGY AND ELECTIVE-2

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Objectives:**

- *To understand the aquifer properties.*
- *To gain knowledge on application of Geophysics in Groundwater studies.*
- *To learn to represent the groundwater data graphically.*
- *To learn photo interpretation techniques*
- *To understand to evaluate isotopic data*
- *To Evaluate urbanization using Remote sensing.*

**Course Outcome**

| | |
|---|---|
| CO1: | Remember to water table contours and determination of flow direction of water |
| CO2: | Understand the estimation of porosity and permeability of rocks, pumping test and preparation and interpretation of water table maps. |
| CO3: | Apply photo interpretation elements and remote sensing techniques for various geological investigations. |
| CO4: | Analyze physical and chemical properties of marine water |
| CO5: | Evaluate isotopic data for various analysis. |
| CO6: | Create maps and models related to urban geology<br>. |

**Course Outline:**

**ADVANCED HYDROGEOLOGY**

- Preparation of water table contours.
- Determination of flow direction of water.
- Determination of porosity of rocks.
- Determination of permeability of rocks.
- Analysis and interpretation of hydrographs.
- Estimation of infiltration capacity.
- Chemical analysis of water.
- Pumping test – time drawdown and time recovery tests and evaluation of aquifer.
- parameters. Step drawdown tests.
- Resistivity survey for groundwater exploration.
- Study of well logs.
- Graphical presentation of water analyses.

**ADVANCED REMOTE SENSING AND GIS**

Visual image interpretation, Identification of structures and lineaments, Exercises on groundwater exploration using remote sensing techniques. Study and nature of aerial photographs resolution, mosaics, symbols, gully, pattern and drainage analysis, image parallax; determination of scale, height, dip, slope, vertical exaggeration and image distortion. Geo-referencing, preparation thematic maps, layout preparation.

**ISOTOPE GEOLOGY**

The following exercise may be done with the given analytical data : The age of the earth, the geologic time scale, relative and absolute dating, radiocarbon (carbon-14) dating 14c dating
The age equation, The Rb-Sr, Sm-Nd, Re-Os and Lu-Hf methods, isochrons , The U-Pb and Pb-Pb methods, K-AR and 40Ar/39Ar dating.

**URBAN GEOLOGY**

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

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember to water table contours and determination of flow direction of water | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the estimation of porosity and permeability of rocks, pumping test and preparation and interpretation of water table maps. | PO1,PO3 | H | PSO3, | H | K2 |
| CO3 | Apply photo interpretation elements and remote sensing techniques for various geological investigations. | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze physical and chemical properties of marine water | PO3, PO6 | M | PSO3, PSO6 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO5 | Evaluate isotopic data for various analysis. | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create maps and models related to urban geology . | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

# IGNEOUS PETROLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To understand different groups of igneous rocks and the processes involved in their formation.*
- *To understand the chemistry and physics of melts and their behavior under varying temperature and pressure conditions, and tectonic conditions.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the distribution of various rock types in the earth's crust and mantle |
| **CO2:** | Understand the physical and chemical processes that produce the full range of igneous rock types. |
| **CO3:** | Apply y Igneous rocks with respect to different standard classification schemes. |
| **CO4:** | Analyze the crystallizing phase equilibrium of multi component magma system and Obtain knowledge on the role and behaviour of major and trace elements in crystallization processes |
| **CO5:** | Evaluate various types of igneous rocks occurring in different tectonic settings on the basis of physical and chemical characters. |
| **CO6:** | Create information of various types of Igneous rocks occurring in India |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT-I**

Magma- its nature and composition; Factors controlling evolution of magma; Introduction to mantle petrology, mantle metasomatism and mantle heterogeneities.Classification of Igneous Rocks: classification based on mineralogy: color index, CIPW classification, Tabular classification-IUGS classification. Classification based on chemical composition: silica percentage, silica saturation, Alumina saturation, Alkali Lime Index, Total Alkali Silica.

**UNIT-II**

Application of physical chemistry in petrogenesis-phase rule and equillibrium in silicate system - consolidation of magma with binary systems and ternary systems -crystallization of two component systems diopside – anorthite system, alibite-anorthite system, leucite - silica system, and crystallization of three component systems Alibite -anorthite – diopside system, Anorthite –

forsterite - silica system, Diopside-forsterite-silica system Nephline-kalsilite-silica system and Anorthite-leucite-silica system.

**UNIT-III**

Magmatism in relation to plate tectonics: Chemical characteristics of igneous rocks in the following tectonic setting: Mid Oceanic Ridge, Island Arcs, Active Continental Margins, Oceanic islands, continental flood basalts and Continental Rifts. Plume magmatism and hot spots.

**Unit IV**

Petrography and Petrology – Granite clan, Syenite clan, Gabbro clan, Lunar rocks, Ultrabasic and Ultramafic rocks, Peridotite, Dunite, Lamprophyre, Pegmatite, Aplite, Basalt, Spillite and keratophyre.

**UNIT V**

Petrogenesis of Granite, Pegmatites, Alkaline rocks, Anorthosites, Carnbonatites, Charnockite, Ultrabasic rocks and Lamprophyres.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the distribution of various rock types in the earth's crust and mantle | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand the physical and chemical processes that produce the full range of igneous rock types.. | PO2,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply y Igneous rocks with respect to different standard classification schemes. | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze the crystallizing phase equilibrium of multi component magma system and Obtain knowledge on the role and behaviour of major and trace elements in crystallization processes | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate various types of igneous rocks occurring in different tectonic settings on the basis of physical and chemical characters. | PO7, PO8 | H | PSO6, PSO5 | H | K5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO6 | Create information of various types of Igneous rocks occurring in India | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Tyrrel,G.W,(1963) Principle of petrology. Methunn&co
2. Turner,F.J,Verhoogen,J.(1960). Igneous and Metamorphic petrology, McGraw Hill Co,Newyork.
3. Bowen,n.l.,(1968) -Evolution of igneous rocks dover publication.
4. Huang,T,(1962)-Petrology McGraw hill book.Co .,
5. Hatch, F.E, Wells, A.K and Wells, M.K, (1949) Petrology of igneous rocks, Thomas Mury andco.
6. Hyndman, Donald, (1972) Petrology of Igneous and Metamorphic rocks, McGraw Hill bookco.
7. Albert Johannsen, (1962), A Descriptive Petrography of the Igneous Rocks:Vol.I Allied pacificprivate limited, Bombay.
8. Anthony Hall, (1996), Igneous Petrology, Second Edition, Longman Group Ltd., UK.
9. Best., (1986), Igneous Petrology., CBS Publication.
10. Bose, M.K., (1997). Igneous Petrology., World Press.
11. McBirney, A.R., (1993), Igneous Petrology, Jones &Barlet Publ.
12. Gupta, Alok (1998) Igneous Rocks, Allied Publishers Limited.
13. Fitton, J.G. Upton, B.J.G. (Eds) (1987) Alkaline Igneous Rocks, Geological Society, London.
14. Middlemost, E.A.K. (1985) Magmas and Magmatic Rocks, Longman.
15. Sood, M.K. (1982) Modern Igneous Petrology, Wiley-Interscience Publ., New York.

## SEDIMENTARY PETROLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To give a broad understanding of how sedimentary rocks form and how they evolve as they undergo burial.*
- *To understand its composition, lithification and diagenesis.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the concepts of sediments and its classification |
| **CO2:** | Understand processes of sedimentation and sedimentary structures |
| **CO3:** | Apply the knowledge of tectonic settings to classify sedimentary basins |
| **CO4:** | Analyze data regarding provenance, paleocurrents and facies. |
| **CO5:** | Evaluate sedimentary environment, seismic and sequence studies |
| **CO6:** | Create sedimentary sequence based on various depositional systems and facies of a given region |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Sedimentary processes: Rock cycle, weathering, transportation, deposition, digenesis and lithification. Mode and mechanism of sediment dispersal, classification, source and transporting agencies of sediments, Fluvial, lacustrine and eolian processes.Role of weathering and sedimentation in evolution of continental crust. Depositional environments –Facies: Terrestrial- Fluvial, glacial, aeolian and lacustrine systems. Transitional- deltaic, beach and barrier island, estuarine and tidal flat systems.

**UNIT II**

The texture of sediments and sedimentary rocks: Concept of particle size and grade scale. Parameters of frequency distribution – mean, mode, sorting coefficient, skewness and kurtosis and their significance.Graphic parameters of Folk and Ward, application in palaeo-environment

studies.Shape and roundness -Porosity and permeability - Mineral as provenance indicators. Structures of sedimentary rocks: Structures of mechanical, chemical and biogenic origin. Flow regime concept.

**UNIT III**

Origin of sedimentary rocks: mechanical, chemical and biological rocks. Classification of sedimentary rocks: Siliciclastic rocks – conglomerates, breccia, sandstones, mud rocks- their description, classification and diagenesis. Biogenic, chemical and other nonsiliclastic rocks – carbonate rocks- types, classification and their diagenesis. Siliceous, phosphatic and iron-rich and evaporite sediments and sedimentary rocks- varieties and environments of formation.

**UNIT IV**

Methods of heavy minerals separation and their significance in sedimentary Petrology- sedimentary environments - physical and chemical factors in sedimentation. Types of sedimentary basins and their tectonic settings– divergent, intraplate, convergent, transform and hybrid settings- fore arc, back arc and retro arc basins. Sedimentary basins of India and its tectonic framework.

**UNIT V**

Dynamics of Sedimentation – Sedimentation in Dams and Reservoirs – Sedimentation and Highway engineering – foundation problems in sedimentary terrain: highway bridges, separation structures , and tunnelling – sedimentary geology of the alluvial valley and its influence on foundation problems, Relation of Landslides to sedimentary features.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO 1 | Remember the concepts of sediments and its classification | PO1 | H | PSO1, PSO2 | H | K1 |
| CO 2 | Understand processes of sedimentation and sedimentary structures | PO2,PO3 | H | PSO3, PSO4 | H | K2 |
| CO 3 | Apply the knowledge of tectonic settings to classify sedimentary basins | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO 4 | Analyze data regarding provenance, paleocurrents and | PO3, PO6 | M | PSO5, PSO7 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | facies. | | | | | |
| CO 5 | Evaluate sedimentary environment, seismic and sequence studies | PO7, PO8 | H | PSO6, PSO5 | H | K5 |
| CO 6 | Create sedimentary sequence based on various depositional systems and facies of a given region | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT and REFERNCE BOOK**


1. Allen, J.R.L., 1985: Principles of Physical Sedimentation, George Allen &Unwin.
2. Friedman, G.M and Sanders, J.L., 1978: Principles of Sedimentology, John Wiley.
3. Nichols, G., 1999: Sedimentology and Stratigraphy. Blackwell.
4. Reading, H.G. 1996: Sedimentary Environments. Blackwell.
5. Davis, R.A. Jr., 1992: Depositional Systems. Prentice Hall.
6. Einsele, G., 1992: Sedimentary Basins. Springer Verlag.
7. Reineck, H.E. and Singh, I.B., 1980: Depositional Sedimentary Environments. Springer –Verlag.
8. Prothero, D.R. and Schwab, F., 1996: Sedimentary Geology. Freeman.
9. Miall, A.D., 2000: Principles of Sedimentary Basin Analysis. Springer Verlag.
10. Pettijohn, F.J., Potter, P.E. and Siever, R., 1990: Sand and Sandstone. Springer Verlag.
11. Blatt, H, Murray, G.V. and Middleton, R.C., 1980: Origin of Sedimentary Rocks.
12. Bhattacharya, A and Chakraborti, C., 2000: Analyses of Sedimentary Successions. Oxford –IBH
13. Boggs Sam Jr. , 1995 : Principles of Sedimentology and Stratigraphy, Prentice Hall
14. Sengupta, S., 1997: Introduction to Sedimentology, Oxford – IBH

15, Selley, R.C., 1976: An Introduction to Sedimentology, Academic Press, London

## RESEARCH METHODOLOGY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To make the students aware about types, approaches and methods of research in Geology.*
- *To orient the students to design and prepare geological research proposal and research papers.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the *types, approaches and methods of research in geology* |
| **CO2:** | Understand literature review |
| **CO3:** | Apply the knowledge of tectonic settings to classify sedimentary basins |
| **CO4:** | Analyze geological samples using instruments and data collection methods |
| **CO5:** | Evaluate and write research proposal or industry project plan |
| **CO6:** | Create report for research articles and papers |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Concept and definition of Research: academic, basic, fundamental research, applied research, theoretical, conventional and experimental research. Concepts and needs of researchhypothesis. 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**

Types of data: primary and 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. Structure of thesis - Copyright waiver- Declaration - Title page - Abstract - Acknowledgments - Table of contents - Introduction - Literature review - Materials and Methods - Results and discussion - Conclusions and suggestions forfurther work – Summary - References – Bibliography - Footnotes

and endnotes and appendices.

**UNIT III**

Literature survey and review- use of digital library - online resource - necessity of review of literatures. 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 IV**

Construction and use of wind rose, fence diagram, Wolf's net, equal area, trilinear diagram. Pre-field preparations, Field sampling equipments, Preparation of topographic maps, Field mapping and documentation, sampling Procedure and sampling techniques for palaeontological, stratigraphic, petrological, geochemical, geophysical and hydrogeological studies. Sample labelling.

**UNIT V**

Geological Laboratory Procedures: Maceration techniques, thin section making, induration techniques for unconsolidated sediments, tracers and staining techniques. Applications of Polarizing microscopes, ore microscopes, Scanning Electron Microscope, mirror stereoscope, heavy mineral separators (mechanical and electromagnetic). Analytical instruments: General principles, description and uses of following; XRF, XRD, AAS, EPMA, ICP – MS.

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the *types, approaches and methods of research in geology* | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand literature review | PO2,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply the knowledge of tectonic settings to classify sedimentary basins | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze geological samples using instruments and data | PO3, PO6 | M | PSO5, PSO7 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | collection methods | | | | | |
| CO5 | Evaluate and write research proposal or industry project plan | PO7, PO8 | H | PSO6, PSO5 | H | K5 |
| CO6 | Create report for research articles and papers | PO3, PO8 | H | PSO8 | H | K6 |

**Mapping of Cos to POs and PSOs**

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Bruce, L. B. (2001) Qualitative Research Methods for Social Sciences by, Allyn and Bacon,Boston.
2. John, W. C., (2011).,Research Design: Qualitative, Quantitative and Mixed MethodsApproaches, Sage Publications, Thousand Oaks.
3. Lester, James, D. and Lester Jr. J. D., (2007) Principles of Writing Research Papers , Longman,New York.
4. Frank A. Settle, (1997)., Handbook of Instrumental Techniques for Analytical Chemistry by,Prentice Hall, Upper Saddle River, NJ.
5. Hutchinson, C.S., (1974). Laboratory hand book of Petrographic Techniques, John Wiley
6. Phillips, E.M and Pugh, D.S., (1994) . 'How to get a PhD: a handbook for students and theirsupervisors'. Open University Press, Buckingham, England.
7. Tufte, E.R.,( 1983)., 'The visual display of quantitative information'. Graphics Press, Cheshire,Conn.
8. Mishra R.P., (1989)., Research Methodology. Concept Publishing Co, New Delhi.
9. Comption R.R., (1962)., Manual of field geology, Wiley.
10. Lahee H., (1959).. Field geology, McGraw-Hill.
11. D.L. Elhance (1973) Practical Problem in Statistics. KitabMahal, Allahabad,
12. Kothari. C. R. (2004) Research Methodology: Methods and Techniques, New Age International.
13. Kumar, Rajendar (2009) Research Methodology, Pub. APH Publishing .
14. D K (2006) Research Methodology, Pub. Excel Books India.
15. Gupta, Mukul and Gupta, (2010) Deep Research Methodology, Pub.PHILearning Pvt. Ltd.

## ELECTIVE-3 FUEL AND APPLIED GEOLOGY

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Code:**

**Course Objectives:**

- *To study on energy resources in Indian sedimentary basins and its exploration techniques.*
- *To make the students aware about engineering properties of rocks.*
- *To understand the various mining and drilling methods.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the *types and classifications of geology and energy resources* |
| **CO2:** | Understand processes of formation of coal, petroleum and nuclear minerals. |
| **CO3:** | Apply the chemical characterization of oil, coal and atomic minerals |
| **CO4:** | Analyze favorable zone for entrapment of oil and gas and also grades of coal |
| **CO5:** | Evaluate various engineering properties of rocks and its application civile engineering projects. |
| **CO6:** | Create wide knowledge in various drilling logging methods. |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Introduction to Indian and global fuel Industry. Scope and Application of fuel Industry. Role of Geologist in energy scenario. Future trends in fuel Industry. Introduction to solid, liquid and gaseous hydrocarbons. Origin of Petroleum: Inorganic and Organic Origin – current Theory – nature of Organic source materials – Marine and non-marine organic matter – Transformation of organic matter into Petroleum. Subsurface environment – water, temperature, pressure and fluid dynamics.

**UNIT II**

Physical and chemical properties of Petroleum. Occurrence of Petroleum – surface occurrence and subsurface occurrence. Migration and accumulation of Petroleum –Primary Migration – Secondary migration, Tertiary migrations, Vertical migrations and time of accumulation. Stratigraphic barriers – Reservoir Traps – anticlinal theory- Classifications of Traps – Structural,

Stratigraphic and combination traps. Assessment of reserves and types of reserves. Geological significance of pollens, microfossils in hydrocarbon exploration- Remote sensing techniques in hydrocarbon exploration.

**UNIT III**

Definition and origin of kerogen and coal, Sedimentology of coal bearing strata, Rank, grade and type of coal, Indian and International classifications, chemical characterization, Techniques and methods of coal microscopy. Application of coal petrology. Coal mining methods, Room and Pillar method, Longwall advancing Long wall retreating, Horizon mining , Underground hydraulic mining and strip mining. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India

**UNIT IV**

Prospecting, Sampling and evaluation of ore resources. Definition of terms – Open cast and underground mining. Alluvial mining, Underground mining methods. Introduction to oil well drilling – types of drilling – rotary and cable tool drilling. Formation evaluation of Petroleum – logging methods – Temperature log, electrical log, sonic log, porosity log, radioactivity log, micropaleontological log- Formation parameters. Vertical Seismic profile.

**UNIT V**

Role of Geology in Civil engineering: Engineering properties of rocks. Rock as construction, foundation material and road aggregate. Rock mass classification. Geological and Engineering classification of Soils. Geological considerations in the following engineering projects: Dams, reservoirs, tunnels, bridges and highway roads.

Ore Dressing: General Principles- Size reduction, Rod mills, Ball mills and Tube Mills. Screening. Principles of Magnetic separation and electrostatic separation.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the *types and classifications of geology and energy* | PO1 | H | PSO1, PSO2 | H | K1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *resources* | | | | | |
| CO2 | Understand processes of formation of coal, petroleum and nuclear minerals. | PO2,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply the chemical characterization of oil, coal and f atomic minerals | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze favourable zone for entrapment of oil and gas and also grades of coal | PO3, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate various engineering properties of rocks and its application civile engineering projects | PO7, PO8 | H | PSO6, PSO5 | H | K5 |
| CO6 | Create wide knowledge in various drilling logging methods. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Chandra, D., Singh, R.M., Singh, M.P.(2000) Text Book of Coal (Indian Context). Tara PrintingWorks, Varanasi.
2. Leverson, A.L(1970). Geology of Petroleum. Freeman and co.
3. Selley, R. C(1998). Elements of Petroleum Geology, II Edition. Academic Press.
4. Stach, E. et al. (1975)Stach‘s textbook of coal petrology. Berlin: GebruderBorntraeger.
5. Taylor, G.H., Teichmüller, M.., Davis, C.(1998) Organic Petrology: A new handbookincorporating some revised parts of Stach‘s Textbook of Coal Petrology.
6. B. G. Deshpande (2019) The World of Petroleum, New Age International Private Limited

7. BhagwanSahay (1994) Petroleum Exploration and Exploitation Practices, Allied PublishersPrivate, Limited
8. Gokhale, K.V. and K.D. Rao, T.C., (1973). Ore deposits of India. Thomson Press India Ltd.,Delhi.
9. Krishnaswamy, S., (1972). India‘s Mineral Resources, Oxford & IBH Publishing Co., Chennai.
10. Bateman, A.M., (1961). Economic Mineral Deposits, Asia Publishing House.
11. John M Hunt Petroleum Geochemistry and Geology, W H Freeman and Company, 1996.
12. North, F.K., Petroleum geology, Unwin Hyman Inc, USA, 1990.
13. Chapman R.E, Petroleum Geology, Elseiver Science Publishing company Inc. Newyork, 1983
14. Jon Gluyas& Richard Swarbrick, Petroleum Geoscience, Blackwell Science publishing Ltd UK2004.
15. Knut Bjorlykke, Petroleum Geoscience- From Sedimentary to Rock Physics, SpringerHeidelberg Dordrecht, London, New York 2010.

## ELECTIVE-3 MINING GEOLOGY AND GEOTECHNICAL STUDIES

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 1 |

**Course Code:**

**Course Objectives:**

- *To understand the fundamental concepts of various mining methods and its terminologies.*
- *To provide knowledge on geological investigation for site selection of engineering projects and the important engineering properties of rock.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the *types and classifications ore and mining* |
| **CO2:** | Understand engineering properties of rocks pertaining to landslides; Geological investigations during the construction of bridges and highways |
| **CO3:** | Apply the Geological investigations for various resources |
| **CO4:** | Analyze ore reserve estimation for surface and underground deposits. |
| **CO5:** | Evaluate surface mining methods and ore estimation |
| **CO6:** | Create report for mine survey using surveying methods |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Mining terminologies: Methods of mining – open cast: manual, mechanised and Glory hole mining. Underground mining: – Gophering, Breast stoping, open underhand stopping, open Overhand stopping, Pillar and Chamber. Alluvial mining: Sluicing, Hydraulicking, drift mining, dredging, derrick and cableway, Shaft sinking. Mine support and ventilation.

**UNIT II**

Coal mining methods: Surface Mining Methods – Strip mining, Open-pit mining, Auger mining, Mountaintop removal mining. Underground Mining Methods– Room-and-pillar mining, Longwall mining, Retreat mining, Blast mining and Horizon mining. Sea Bed mining – Marine mining equipment's and methods – General ideas.

**UNIT III**

Principles of mineral dressing: Types and uses of Crushers, Grinding mills, Screens and Classifiers. Physical methods of separation by grain size, gravity and magnetism. Chemical methods – reagents and their functions. Floatation. Flowsheets and its importance. Plans to be prepared and maintained in a mine – EMP, Mining plan, Mine closure plan, Surface plan etc. Mining legislation in India – National Mineral Policy. Mining hazards. Mining and environment.

**UNIT IV**

Role of Geology in Civil engineering: Engineering properties of rocks. Rock as construction, foundation material and road aggregate. Rock mass classification – general parameters of RMR, RQD and SMR. Geological and Engineering classification of Soils. Geological considerations in the following engineering projects: Dams, reservoirs and tunnels, bridges and highway roads.

**UNIT V**

` Reservoir sedimentation: Causes and effects, desilting methods. Coastal erosion – Near shore dynamics, erosion mechanisms and longshore drift. Measures for controlling coastal erosion – sea walls, groins and harbours. Seismicity in stable continental regions of India and Seismic Zonationmaps, Earthquake resistant structures

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the *types and classifications ore and mining* | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand engineering properties of rocks pertaining to landslides; Geological investigations during the construction of bridges and highways | PO2,PO3 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply the Geological investigations for various resources | PO5, PO6, | M | PSO5, PSO6 | M | K3 |
| CO4 | Analyze ore reserve estimation for surface and | PO3, PO6 | M | PSO5, PSO7 | M | K4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | underground deposits. | | | | | |
| CO5 | Evaluate surface mining methods and ore estimation | PO7, PO8 | H | PSO6, PSO5 | H | K5 |
| CO6 | Create report for mine survey using surveying methods | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Arogyaswamy, R.N.P.(1973) Courses in Mining Geology, Oxford and IBH pub. Co.
2. Howard L Hartman,and M.Mutmansky (2002),Introductory Mining Engineering, John Wileyand Sons Inc.
3. Barry A. Wills, Tim Napier-Munn (2015). Mineral Processing Technology, An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, Elsevier Science & TechnologyBooks
4. R.M Umathy,( 2002) Text book of Mining geology, Dattsons.
5. Gaudin, A.M. (1938) Principles of Mineral Dressing, McGraw Hill.
6. Taggart, A.P. (1964) Handbook of Mineral Dressing, Willey.
7. Kenneth J.P. (1982) Marine Geology, Prentice Hall Inc.
8. F.P. Shepard. (1967) Submarine geology, Harper International.
9. Krynine, D.P. and Judd, W.R. (2001) Principles of Engineering geology and Geotechnics, CBSPublishers and Distributors, New Delhi.
10. Petters, W.C. (1987) Exploration and Mining Geology. John Wiley.
11. Reedman, JH (1979) Techniques in Mineral Exploration, Allied Scientific Publishers.
12. Robert B. Johnson and Jerome V. Degraff (1976) Principles of Engineering Geology, JohnWilley and Sons .
13. ChennaKesavulu, (1993) Text book of Engineering Geology, Macmillan India Ltd, Madras.
14. Donald P. Coduto, (2001) Geotechnical engineering principles and practices, PrenticeHall of India, Pvt. Ltd, New Delhi.
15. Schultz, J.R. & Cleaves, A.B. (1951). Geology in Engineering, John Willey &Sons.,

## ELECTIVE-3 NANOGEOSCIENCE

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**

- *To make the students understand the Nanogeology and its applications in the earth sciences.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember the *types and classifications* Nanogeoscience: |
| CO2: | Understand the concepts and principles of Nano-mineralogy |
| CO3: | Apply the nano system in public utility |
| CO4: | Analyze nano materials using latest and sophisticated equipment's |
| CO5: | Evaluate Properties at the nanoscale |
| CO6: | Create awareness in usages of nanomaterials |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT – I**

**Introduction to Nanogeoscience:** Introduction – Definition – Applicable fields of study – Types and environment of nanoparticles – Natural and anthropogenic inputs – Size – dependent stability and reactivity of nanoparticle – Benefits – Risks – Remediation.

**UNIT – II**

**Nano-mineralogy**: Nanocrystal – Transformation of nanoparticle structure – Nanoparticle growth – surface impurities – Biomineralization: microbial biomineralization – Nano-standard materials.

**UNIT – III**

**Nano-systems:** Mineral-water-bacteria – Biomimetic Soils and sediments – Atmospheric particulates- Carbon cycle – Organic-Inorganic Nanoparticle Interactions in sedimentary systems – Magnetic nanomaterials – Biogenic magnetite – Zeolites, Clays, Fe-Ti oxides, and phosphate minerals.

**UNIT – IV**

**Nanotechnology**: Brief principles and description of: calorimetry, UV visible Infra-Red, Raman

and NMR spectroscopy, Scanning electron microscopy (SEM) Atomic Force Microscopy, Electron Microprobe and High-Resolution Transmission Electron Microscopy – Definition and applications of nano-satellites and micro-satellites.

**UNIT -V**

**Nanomaterials:** Properties at the nanoscale – Categories: Metal and Ceramic Nanopowders, Carbon Nanotubes and Nanospheres, Nanowires, Quantum Dots, Dendrimers, Protein and Structured Polymer Strands – Nanometrology – Dispersions – Top-down and Bottom-up methods.

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the *types and classifications* Nanogeoscience: | PO1 | H | PSO1, PSO3 | H | K1 |
| CO2 | Understand the concepts and principles of Nano-mineralogy | PO2,PO3 | H | PSO2, PSO4 | H | K2 |
| CO3 | Apply the nano system in public utility | PO5, PO6, | M | PSO4, PSO6 | M | K3 |
| CO4 | Analyze nano materials using latest and sophisticated equipment's | PO4, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate Properties at the nanoscale | PO5, PO8 | H | PSO6, PSO5 | H | K5 |
| CO6 | Create awareness in usages of nanomaterials | PO3, PO8 | H | PSO8 | H | K6 |

**Mapping of Cos to POs and PSOs**

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**

1. Andersen, M.M. and Rasmussen, B.,(2006). Nanotechnology development

in Denmark-environment opportunities and risk. Riso National Laboratory, Denmark.
2. Chemical Industry R&D Roadmap for Nanomaterials By Design: From Fundamentals toFunction,2003. www.ChemicalVision2020.org.
3. Cientifica, (2003).” The Nanotechnology Opportunity Report”,2nd Edition, ExecutiveSummary. CMP Cientifica,2002. “Nanotechnology”The Tiny Revolution.
4. Nartikar.Y.Y. Fu.( 2010).Hand book. Nanoscience and Technology. Oxford University Press.
5. Muralidharan. V.S. M (1998). Nanoscience. Alagappa Chettiar College of Engineeringtechnology.
6. Mick Wilson (2002 ) Nanotechnology: Basic Science and Emerging Technologies. CRC Press. Gregory L. Timp(1999) Nanotechnology . AIP-Press.
7. Sengupta, Amretashis, Sarkar, Chandan Kumar (2015) Introduction to Nano:Basics toNanoscience and Nanotechnology., Springer.
8. G Ali Mansoori (2005) Principles of nanotechnology: Molecular-based study of condensed matter in Small Systems., World Scientific Publishing Company.
9. Mildred S. Dresslhaus, Gene Dresslhaus and PhaedonAvouris 2001). Carbon NanotubesSynthesis, Structure, Properties and Applications .Springer.
10. G.L. Hornyak, H.F. Tibbals, J. Dutta, and J.J. Moore,(2009).Introduction to Nanoscience andNanotechnology., CRC Press.
11. C. Poole, and F. Owens, (2007) Introduction to Nanotechnology .,Wiley India.
12. R. Kelsall, I.M. Hamley, and M. Geoghegan, (2005) Nanoscale Science and Technology., JohnWiley.
13. T. Pradeep (2017) NANO: The Essentials Understanding Nanoscience and Nanotechnology,McGraw Hill.
14. Maria Benelmekki (2015) An introduction to nanoparticles and nanotechnology., Morgan &Claypool Publishers

## PRACTICAL 5 IGNEOUS PETROLOGY AND SEDIMENTARY PETROLOGY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Code:**

**Course Objectives:**

- *To develop the practical knowledge and skill on petrography of igneous and sedimentary rocks.*
- *To prepare practical representation of data and variation diagram of Harker and Niggli.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember to Identify the different types of igneous and sedimentary megascopic rock samples |
| CO2: | Understand the Petrochemical calculations CIPW Norm . |
| CO3: | Apply the fundamental studies to classify rock types under microscope and identify constituent minerals |
| CO4: | Analyze sphericity and roundness of grains, Sieve analysis of sedimentary particles |
| CO5: | Evaluate Graphical presentation of data and determination of statistical parameters |
| CO6: | Create Variation diagram of Harker and Niggli. |

**Course Outline:**

**IGNEOUS PETROLOGY**

1. Megascopic and Microscopic study of different Igneous Rocks
2. Petrochemical calculations CIPW Norm
3. Variation diagram of Harker and Niggli.

**SEDIMENTARY PETROLOGY**

1. Megascopic and Microscopic study of different Sedimentary rocks.
2. Determination of sphericity and roundness of grains, Sieve analysis.
3. Graphical presentation of data and determination of statistical parameters.

**Mapping of Cos to POs and PSOs**

| | Course Outcome | PO Addressed | Correlation Level | PSO Addressed | Correlation Level | Cognitive Level |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO1 | Remember to Identify the different types of igneous and sedimentary megascopic rock samples | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the Petrochemical calculations CIPW Norm . | PO1,PO3 | H | PSO3, | H | K2 |
| CO3 | Apply the fundamental studies to classify rock types under microscope and identify constituent minerals | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze sphericity and roundness of grains, Sieve analysis of sedimentary particles | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluate Graphical presentation of data and determination of statistical parameters | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create Variation diagram of Harker and Niggli. . | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

## PRACTICAL -6 *RESEARCH* METHODOLOGY AND ELECTIVE-3

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Code:**

**Course Objectives:**

- To get knowledge on the problems related to research methodology
- students able to understand the geological structures and features in mining and geotechnical studies
- Evaluate the bore hole data and their interpretation, Logging exercises in petroleum exploration
- To able to calculate the basic experimental data for nano sciences.

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember the basic geological calculation |
| CO2: | Understand the problems related to research methodology. |
| CO3: | Apply the geological parameters in oil and coal reserve estimations. |
| CO4: | Analyze geological structures and features in mining and geotechnical studies. |
| CO5: | Evaluation of bore hole data and their interpretation, Logging exercises in petroleum exploration |
| CO6: | Create Calculation based on basic experimental data fro nano sciences. |

**Course Outline:**

**RESEARCH METHODOLOGY**

Problem related to research methodology syllabus

**FUEL AND APPLIED GEOLOGY**

Megascopic identification coals , Reserve estimation of coal, preparation of Panel and Fence diagrams for coal, Preparation of map for Indian coal reserve locations and petroleum reserve. Exercises on calculation of oil reserves, Evaluation of bore hole data and their interpretation, Logging exercises in petroleum exploration.
Problem related to Mining Geology and Engineering properties of rocks.

**MINING GEOLOGY AND GEOTECHNICAL STUDIES**

Determination of direction and dip of sub-surface mineral deposit, Determination of persistence of coal seam at depths, Determination of true dip based on apparent dips, Determination of true

dip and direction of the mineral in a quarry face ,Determination of vertical thickness of dipping mineralization in different directions, Determination of true dip, dip direction, thickness and distance of outcrop from the nearest borehole, Estimation of reserves in underground mine using borehole data ,Mine Planning – Open-cast mining exercise on geological section, Mine Planning – Underground mining exercise on geological section.

Calculation of compressive strength, Shear strength and Tensile strength of rocks, Foundation strength calculations, Select a suitable site from geological and topographical maps for dam and tunnel and other constructions.

**NANOGEOSCIENCE**

Identification of nano-minerals. Size and shape studies of nan-mineral. Identification of nano-fossils.,Calculation based on basic experimental data.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the basic geological calculation | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the problems related to research methodology . | PO1,PO3 | H | PSO3, | H | K2 |
| CO3 | Apply the geological parameters in oil and coal reserve estimations. | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze geological structures and features in mining and geotechnical studies. | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluation of bore hole data and their interpretation, Logging exercises in petroleum exploration | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create Calculation based on basic experimental | PO3, PO8 | H | PSO8 | H | K6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | data from nano sciences. | | | | | |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

# METAMORPHIC PETROLOGY

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Code:**
**Course Objectives:**

*To identify metamorphic rocks and metamorphic environment.*

*To get the knowledge of mineral assembles in metamorphic rocks and facies.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember the types of metamorphism |
| CO2: | Understand the metamorphic minerals in thin section and interpret met textures and able to comment on met grade and types of metamorphism |
| CO3: | Apply metamorphic grade and Facies based on mineral assemblages, PT conditions, and bulk rock chemical composition. |
| CO4: | Analyze quantitative and qualitative mineral and mineral to infer the metamorphic conditions and processes study of metamorphic rocks on chemical system |
| CO5: | Evaluate magmatic and geodynamic processes and their signatures |
| CO6: | Create phase diagrams to understand the relationships between mineral assemblages and plots of ACF, AKF, AFM diagrams. |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT-I**

Concept of Metamorphism: The limits of metamorphism – Metamorphic agents and changes – Temperature, Pressure, stress, and Metamorphic fluids. Types of metamorphism: Contact Metamorphism: Pyrometamorphism – Regional metamorphism-Orogenic Metamorphism – Burial Metamorphism – Ocean Floor Metamorphism – Hydrothermal Metamorphism – Fault-zone Metamorphism . Mineralogical Phase rule: Gibbs and Goldschmidt's rule.

**UNIT-II**

Classification of metamorphic rocks. Metamorphic textures and structures. Metamorphic grades and zones concepts-depth zones, contact metamorphic zones, Barrowian zones, Buchan zones, Sanbagawa zones, Franciscan zones, Dharwarian zones. Paired metamorphic belts.

**UNIT-III**

Concept of metamorphic facies: facies classification of metamorphic rocks. Views of Eskola,

Winkler, Turner and Verhoogen. Phase relations: ACF, AFM and AKF phase diagrams for metamorphic mineral assemblages. Gibbs Phase Rule and Mineralogical Phase rule of closed and open systems. Metamorphic differentiation. Metasomatism, Granitisation.

**UNIT-IV**

Thermal, cataclastic and regional metamorphism and their effects on carbonates, argillaceous, arenaceous and acid, basic and ultrabasic igneous rocks. Retrograde metamorphism.

**UNIT-V**

Migmatisation, Charnockitisation, Palingenesis, Origin of Eclogites, origin of Amphibolites metamorphism in relation to plate tectonics, Magmatic emplacements and orogenesis.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the types of metamorphism | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand the metamorphic minerals in thin section and interpret met textures and able to comment on met grade and types of metamorphism | PO2,PO4 | H | PSO3, PSO4 | H | K2 |
| CO3 | Apply metamorphic grade and Facies based on mineral assemblages, PT conditions, and bulk rock chemical composition. | PO3, PO5, | M | PSO4, PSO6 | M | K3 |
| CO4 | Analyze quantitative and qualitative mineral and mineral to infer the metamorphic conditions and processes study of metamorphic rocks on chemical system | PO5, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate magmatic and geodynamic processes and their signatures | PO5, PO8 | H | PSO6, PSO4 | H | K5 |
| CO6 | Create phase diagrams to understand the relationships between mineral assemblages and plots of ACF, AKF, AFM diagrams. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$– Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. John D Winter, (2010)., Principles of Igneous and Metamorphic Petrology- PHI publishers
2. Turner, F.J., (1990)., Metamorphic Petrology, McGraw Hill, New York
3. Yardley, B.w., (1989)., An Introduction to Metamorphic Petrology-Longman, New York
4. Bucher, K. and Frey, M., (1994)., Petrogenesis of Metamorphic Rocks-Springer Verlag
5. Philipotts, A., 1992: Igneous and Metamorphic Petrology-Prentice Hall
6. Kretz, R.,( 1994)., Metamorphic Crystallization-John Wiley
7. Winkler, H.G.F., (1974), Petrogenesis of Metamorphic Rocks, 5th edn., Springer-Verlag.
8. Tyrrell, G.W. (1963). Principles of Petrology, Methunn, Co.
9. BhaskarRao,(1986), Metamorphic petrology, International Book house, Delhi.
10. Williams, H ,F.J Turner and C.M., Ghilbert, 1954, Petrography. W.H. Freeman and Co.,
11. Hyndman, F.D. (1972)., Petrology of Igneous & Metamorphic rocks McGraw Hill.
12. Miyashiro, A. (1973)., Metamorphism and metamorphic belts Allan and Unwin.
13. Best,M.G.(2002), Igneous and Metamorphic Petrology,2nd edition, Blackwell Publishers.
14. Chatterjee, S.C (1974), Petrography of the Igneous and Metamorphic rocks of IndiaMacmillan .
15. Ernst.W.G, (1976), Petrologic Phase Equilibria, W.H. Freeman & Co, USA

## ECONOMIC GEOLOGY AND MINERAL ECONOMICS

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Code:**

**Course Objectives:**

- *To study mineral deposits and processes of formation of mineral deposits and its genesis.*
- *To study the important economic deposits of Tamilnadu and Pondicherry.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember the types of various ore minerals and gangue |
| CO2: | Understand mineralizing processes and occurrence of various economically important minerals with respect to time and space. |
| CO3: | Application of geological raw materials used in various industries on the basis of industrial specifications. |
| CO4: | Analyze surface processes and related ore deposits |
| CO5: | Evaluate occurrence of economic minerals through geologic time |
| CO6: | Create up-to-date knowledge on Indian ore deposits and National mineral policy. |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III:Contact Hours: 1 2
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Scope of economic geology. Mode of occurrences and morphology of ore bodies and relationship with host rocks - Tenor, grade and specification of ores. Textures and Structures of ore and gangue minerals. Mining laws - major and minor minerals - royalty on minerals- an overview of the minesand minerals industry regulation and development.

**UNIT II**

Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption. Mineral conservation and substitution - Outline of National Mineral policy. Marine mineral resources and Law of Sea. Process of formation of mineral deposits: Magmatic concentration – Contact metasomatism-Hydrothermal processes-Metasomatic replacement – Sedimentation- Evaporation – Residual and mechanical concentration – Oxidation and supergene enrichment – Metamorphism.

**UNIT III**

Controls of ore localization, Mineral paragenesis and zoning, Geothermometry, geobarometry,

paragenetic sequence, zoning and dating of ore deposits -Fluid inclusions- wall rock alteration. Metallogenic Epochs and Provinces. Geologic setting and genesis of the following Indian mineral deposits: Iron, Manganese, Chromium, Nickel, Cobalt, Vanadium, Molybdenum, Tungsten, Copper, Lead, Zinc, Tin, Gold, Silver, Aluminium, Magnesium, Titanium, Uranium, Thorium. Mineral wealth of Tamilnadu and Pondicherry.

**UNIT IV**

Minerals used in industry: cement, Abrasives, Refractories, Metallurgical, Fertilizer, Building Industries, Ceramics, Glass, Chemicals, Paints and Pigments and Insulators. Precious and semi-precious minerals

**UNIT V**

Ore microscopy – The ore microscope, Preparation of polished surface of ores, Physical and optical properties of ore mineral, microchemical techniques and applications of ore microscopy. Techniques on ore petrographic studies.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the types of various ore minerals and gangue | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand mineralizing processes and occurrence of various economically important minerals with respect to time and space. | PO2,PO4 | H | PSO3, PSO4 | H | K2 |
| CO3 | Application of geological raw materials used in various industries on the basis of industrial specifications. | PO3, PO5, | M | PSO4, PSO6 | M | K3 |
| CO4 | Analyze surface processes and related ore deposits | PO5, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate occurrence of economic minerals through geologic time | PO5, PO8 | H | PSO6, PSO4 | H | K5 |
| CO6 | Create up-to-date knowledge on Indian ore deposits and | PO3, PO8 | H | PSO8 | H | K6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | National mineral policy. | | | | | |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. Bateman. A.M. (1961). Economic mineral deposits, John Wiley & Sons.
2. Krishnaswamy. S. (1972). India's Mineral Resources, Oxford and IBH, Publishers, New Delhi.
3. Gokhale.K.V.K. and Rao. T.K. (1972). Ore deposits of India, Thomson press, New Delhi.
4. Umeshwar Prasad,(1996.), Economic geology, CBS Publishers and distributors, New Delhi.
5. Edward R. and Atkinsan K. (1986)., Ore deposit Geology, Chapmon and Hall, 1.
6. Deb. S. (1980)., Industrial minerals and rocks of India. Allied publisher. Pvt.Ltd.
7. Evans, A.M., (1993)., Ore Geology and Industrial Minerals, Blackwell
8. Torling, D.H.,(1981)., Economic Geology and Geotectonics., BlackwelSci Publ.
9. Barnes, H.L., (1979)., Geochemistry of Hydrothermal Ore Deposits., John Wiley.
10. Arogyaswamy, R.P.N., (1996)., Courses in Mining Geology, IV Ed., Oxford IBH.
11. Anthony Evans, (1993) Ore Geology and Industrial Mineral, Jhon Wiley & sons, USA,
12. Coggin, B. and Dey, A.K. (1955) India's Mineral Wealth, oup.
13. Craig, J.M. & Vaughan, D.J., (1981): ore Petrography and Mineralogy. John Wiley
14. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
15. Gokhale, K.V.G.K. and Rao , T.C (1978)- Ore deposits of India, their distribution andprocessing, Thosmson press,.

# ADVANCED GEOPHYSICS AND GEOCHEMISTRY

**Course Code:**

| L | T | P | C |
|---|---|---|---|
| 6 | 0 | 0 | 4 |

**Course Objectives:**

- *To understand geophysical prospecting methods that can be used to find out the occurrence and extent of natural resources.*
- *This course teaching the geological history and evolution of earth through isotopic and geochemical signatures.*

**Course Outcomes* (COs):**

| | |
|---|---|
| **CO1:** | Remember the physical and chemical properties of earth and its layers |
| **CO2:** | Understand geochemical and geophysical characteristics of minerals and rocks. |
| **CO3:** | Application of various geophysical and geochemical methods and their field surveys. |
| **CO4:** | Analyze geophysical and geochemical anomalies and their significance in subsurface exploration |
| **CO5:** | Evaluate the geophysical data for exploration for minerals, oil and groundwater |
| **CO6:** | Create geochemical data for exploration for minerals, oil and groundwater |

**Course Outline:**

Unit I: Contact Hours: 12
Unit II: Contact Hours: 12
Unit III: Contact Hours: 12
Unit IV: Contact Hours: 12
Unit V: Contact Hours: 12

**UNIT I**

Introduction – geophysical methods: surface and sub-surface methods and their types. Physical properties of rocks and minerals used in exploration. Gravity method :Newtons law-measurement of gravity, gravimeters, field procedure, reduction and correction of gravity data and interpretation of gravity data. Applications of gravity methods. Magnetic prospecting – definition, principles of magnetic prospecting,Palaeomagnetism- Magnetometers – Field procedure for ground magnetic surveys, smoothening data correction, interpretation , quantitative and qualitative interpretation.Aero magnetic survey.

**UNIT II**

Electrical methods : Resistivity method – Ohm's Law, resistivity, factors affecting resistivity, various types of resistivity methods, configuration factor, response over a layered earth. DC type resistivity meters, field procedure for electrical profiling and sounding, logarithmic curve matching.Interpretation of profiling and sounding field data, uses of modelling in electrical

methods. Introduction to self-potential and induced polarization methods .

**UNIT III**

Seismic methods – Fundamentals of elasticity – Young's modulus, Bulk modulus, Poisson's ratio, elastic waves, laws of reflection and refraction, Huygen's principle, Fermat's principle, Seismic wave theory – Helmhotz's theorem - Seismic instruments – Seismic channel . Geophones : Filters, Amplifier and reproducible and non-reproducible recording device– Seismic timer and field layout – Corrections of seismic data- data processing: Seismic refraction and reflection data- interpretation of seismic data. Applications and factors controlling seismic data.

**UNIT IV**

Origin and cosmic abundance of elements. Geochemical classification of elements. Geochemical cycles. Chemical evolution of the earth. Primary geochemical differentiation. Classification of meteorites. Geochemical constitution of earth's crust, mantle, core and meteorites. Phase transitionsin the mantle. Goldschmidt's classification of elements. Nernst's partition coefficient (compatible and incompatible elements), LILE and HFSE. Major, minor and trace elements, REEs and PGEs.

**UNIT V**

Application of geochemistry in petrogenesis- Harker variation diagrams, differentiation index, AFM diagram, TAS classification diagram, spider diagrams, REE diagram and tectonic discrimination diagram for granitic and basaltic rocks. Oxidation potential, Eh-pH diagrams and their applications in sedimentation process. Introduction to isotope geology: Isotopes, isobars and isotones, stable and radioactive isotopes. Various decay mechanisms- alpha, beta (positron and negatron), gamma decay, electron capture and branched decay. Radioactive decay, half-life and basic equation for age calculation

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember the physical and chemical properties of earth and its layers | PO1 | H | PSO1, PSO2 | H | K1 |
| CO2 | Understand geochemical and geophysical characteristics of minerals and rocks. | PO2,PO4 | H | PSO3, PSO4 | H | K2 |
| CO3 | Application of various geophysical and geochemical | PO3, PO5, | M | PSO4, PSO6 | M | K3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | methods and their field surveys. | | | | | |
| CO4 | Analyze geophysical and geochemical anomalies and their significance in subsurface exploration | PO5, PO6 | M | PSO5, PSO7 | M | K4 |
| CO5 | Evaluate the geophysical data for exploration for minerals, oil and groundwater | PO5, PO8 | H | PSO6, PSO4 | H | K5 |
| CO6 | Create geochemical data for exploration for minerals, oil and groundwater | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

**TEXT AND REFERNCE BOOKS**


1. RamachandraRao, M.B., Prasaranga, (1975)., Outlines of Geophysical Prospecting – Amanual for geologists by University of Mysore, Mysor,.
2. Bhimasarikaram V.L.S. (1990)., Exploration Geophysics - An Outline by., Association ofExploration Geophysicists, Osmania University, Hyderabad,.
3. Dobrin , (1984)., An introduction to Geophysical Prospecting by, M.B. McGraw Hill, NewDelhi.
4. Telford W.M. Geldart L.P., Sheriff, R.E. and Keys D.A. (1976)., Applied Geophysics. Oxfordand IBH Publishing Co. Pvt., Ltd. New Delhi,
5. Parasnis, D.S (1975).Principles of applied Geophysics, Chapman and Hall.
6. Mason, B. and Moore, C.B., (1991), Introduction to Geochemistry, Wiley Eastern.
7. Krauskopf, K.B., (1967)., Introduction to Geochemistry, McGraw Hill.
8. Faure, G., (1986)., Principles of isotope Geology., John Wiley.
9. Hoefs, J., (1980)., Stable Isotope Geochemistry., Springer Verlag
10. Brounlow,A.N. (1979).,Geochemistry, Prentice hall.
11. Kearey, P Brooks (1991) An introduction to geophysical exploration, Blackwell.
12. Krauskopf, E.B. (1979) Introduction to geochemistry, McGraw Hill Book Company, NewDelhi.
13. Gill, R. (1989) Chemical fundamentals of geology, Unwin Hyman, London.
14. Albarede F. (2003) Geochemistry- An introduction, Cambridge university press
15. Faure G. (1986) Principles of isotope geology1, John Wiley & Sons

## PRACTICAL -7 METAMORPHIC PETROLOGY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Code:**

**Course Objectives:**

- T*o develop the skills of identifying the metamorphic rocks and its petrographic characters*.
- *To get expertise on ACF, AKF and AFM diagram.*

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember to Identify the metamorphic rocks in hand specimen |
| CO2: | Understand the Structures and textures in metamorphic rocks. |
| CO3: | Apply the light properties to study metamorphic rocks in thin-section |
| CO4: | Analyze and plotting of chemical data on ACF, AKF and AFM diagrams |
| CO5: | Evaluation and Interpretation of reaction texture |
| CO6: | Create report based on metamorphic grade and type of metamorphism and metamorphic textures for the collected samples. |

**Course Outline:**

**METAMORPHIC PETROLOGY**

1. Study of metamorphic rocks in hand specimen;
2. Study of metamorphic rocks in thin sections;
3. Structures and textures in metamorphic rocks;
4. Interpretation of reaction texture;
5. Plotting of chemical data on ACF, AKF and AFM diagrams;
6. Preparation of metamorphic rock slides.

**Mapping of Cos to POs and PSOs**

| | Course Outcome | PO Addressed | Correlation Level | PSO Addressed | Correlation Level | Cognitive Level |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember to Identify the metamorphic rocks in hand specimen | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the Structures and textures in metamorphic rocks. | PO1,PO3 | H | PSO3, | H | K2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Apply the light properties to study metamorphic rocks in thin-section | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze and Plotting of chemical data on ACF, AKF and AFM diagrams | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluation and Interpretation of reaction texture | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create report based on metamorphic grade and type of metamorphism and metamorphic textures for the collected samples. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze,$K_5$– Evaluate, $K_6$ – Create)

## PRACTICAL- 8 ECONOMIC GEOLOGY AND MINERAL ECONOMICS and ADVANCED GEOPHYSICS AND GEOCHEMISTRY

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 3 |

**Course Code:**

**Course Objectives:**

- *To identify the economic minerals in hand specimen.*
- *To getting knowledge on reserve estimation.*
- *To interpret and explore data collected from Geophysics and Geochemical methods***.**

**Course Outcomes* (COs):**

| | |
|---|---|
| CO1: | Remember to Identify the ore and economic minerals in hand specimen |
| CO2: | Understand the Computation of ore reserves from sampling data |
| CO3: | Apply Estimation of ore reserves by traditional methods. |
| CO4: | Analyze the geochemical properties of water |
| CO5: | Evaluate the data collected from the various geophysical methods |
| CO6: | Create report based on geophysical survey and geochemical data analysis. |

**Course Outline:**

**ECONOMIC GEOLOGY AND MINERAL ECONOMICS**

Identification and description of the following economic minerals:

Magnetite, Ilmenite, Hematite, Pyrite, Pyrolusite, Psilomelane, Chromite, Wulframite, Chalcopyrite, Malachite, Galena, Magnesite, Bauxite, Stibnite, Cinnabar, Gypsum, Barite, Monazite, Rutile, Sillimanite, Kyanite, Corundum, Calcite, Dolomite, Beryl, Asbestos, Orpiment. Computation of ore reserves from sampling data, Estimation of ore reserves by traditional methods.

**GEOPHYSICS**

Geological interpretation of magnetic survey data, Study of seismic map of India, Study of seismic profiles of across southern India, Geological interpretation of seismic survey data, Electrical resistivity survey: Wenner and Shlumberger methods, Plotting and interpretation of electrical resistivity survey data.

**GEOCHEMISTRY**

Following excesses may be done based on experimental/ given analytical data. Samples preservation techniques.

Determination of pH, Electrical Conductivity, Dissolved Oxygen, Titrimetric methods, Determination of Carbonates, Bicarbonates, Total hardness, Chloride, Calcium, Magnesium. Determination of Sodium and Potassium by flame photometry. Determination of Sulphates, Fluoride, Nitrates. Types of Geochemical data analysis and interpretation of common geochemical plot. Geochemical geological materials. Geochemical variation diagrams and interpretations.

**Mapping of Cos to POs and PSOs**

| | **Course Outcome** | **PO Addressed** | **Correlation Level** | **PSO Addressed** | **Correlation Level** | **Cognitive Level** |
|---|---|---|---|---|---|---|
| | | PO1 to PO8 | L/M/H | PSO1 to PSO8 | L/ M/ H | $K_1$ to $K_6$ |
| CO1 | Remember to Identify the ore and economic minerals in hand specimen | PO1 | H | PSO2, PSO3 | H | K1 |
| CO2 | Understand the Computation of ore reserves from sampling data | PO1,PO3 | H | PSO3, | H | K2 |
| CO3 | Apply Estimation of ore reserves by traditional methods. | PO5, PO6, | M | PSO4, PSO5 | M | K3 |
| CO4 | Analyze the geochemical properties of water | PO3, PO6 | M | PSO3, PSO6 | M | K4 |
| CO5 | Evaluate the data collected from the various geophysical methods | PO7, PO8 | H | PSO7 | H | K5 |
| CO6 | Create report based on geophysical survey and geochemical data analysis. | PO3, PO8 | H | PSO8 | H | K6 |

(L – Low, M – Medium, H – High; $K_1$ – Remember, $K_2$ – Understand, $K_3$ – Apply, $K_4$ – Analyze, $K_5$–Evaluate, $K_6$ – Create)

## PRACTICAL 9 FIELD STUDIES AND VIVA VOCE

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0 | 2 |

**REPORT SUBMISSION ON**

1. Geological Mapping
2. Short field trips
3. Geological Long field trip and
4. Industrial/in-plant training

**VIVA VOCE ON**

1. Geological mapping
2. Geological field trip
3. Short field trips and specimen collection.
4. Industrial/In-plant training

## PRACTICAL 10 DISSERTATION AND VIVA VOCE

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 4 |

***PROJECT EVALUATION AND VIVA VOCE***

- Group Project oriented dissertation based on university guidelines must be submitted oneweek before the Practical exams.
- Project evaluation and Viva-Voce .