



BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI - 620024.

**M.Sc., APPLIED GEOLOGY- CURRICULUM STRUCTURE
CHOICE BASED CREDIT SYSTEM -
LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)
(Applicable to the candidates admitted from the academic year 2026- 2027 onwards)**

Sem.	Course	Course Title	Ins. Hrs.	Credit	Exam Hrs.	Marks		Total	
						Int.	Ext.		
I	Core Course - 1 (CC - 1)	Geotectonics and Structural Geology	6	4	3	30	70	100	
	Core Course - 2 (CC - 2)	Palaeontology	6	4	3	30	70	100	
	Core Practical -1 (CP - 1)	Palaeontology, Structural Geology and Surveying Practical	6	4	3	40	60	100	
	Discipline Centric Elective Course - 1 (DCEC-1)	Any one from the list	5	4	3	30	70	100	
	Generic Elective Course – 1 (GEC-1)	Any one from the list	5	3	3	30	70	100	
	Skill Enhancement Course - 1 (SEC-1)	Geology and Mineral Resources of Tamil Nadu	2	2	3	30	70	100	
	Value Added Course – 1 (VAC – 1)*	Geostatistics	-	2*		30	70	100*	
	Total			30	21	-	-	-	600
II	Core Course - 3 (CC - 3)	Advanced Crystallography and Mineralogy	6	4	3	30	70	100	
	Core Course - 4 (CC - 4)	Stratigraphy	6	4	3	30	70	100	
	Core Practical - 2 (CP - 2)	Advanced Crystallography and Mineralogy	6	4	3	40	60	100	
	Discipline Centric Elective Course - 2 (DCEC - 2)	Any one from the list	4	4	3	30	70	100	
	Generic Elective Course – 2 (GEC-2)	Any one from the list	4	3	3	30	70	100	
	Skill Enhancement Course - 2 (SEC - 2)	Field Geology	2	2		30	70	100	
	Non-Major Elective Course - 1 (NMEC - 1)	One Course from Outside Department	2	2	3	30	70	100	
	Total			30	23	-	-	-	700
	Summer Internship / Industrial Activity during the Summer Vacation after 1 st Year								

III	Core Course - 5 (CC - 5)	Igneous and Metamorphic Petrology	6	4	3	30	70	100
	Core Course - 6 (CC - 6)	Sedimentary Petrology	6	4	3	30	70	100
	Core Practical - 3 (CP - 3)	Petrology, Remote Sensing and GIS	6	4	3	40	60	100
	Discipline Centric Elective Course - 3 (DCEC - 3)	Any one from the list	5	4	2	30	70	100
	Generic Elective Course – 3 (GEC-3)	Any one from the list	5	3	2	30	70	100
	Non-Major Elective Course – 2 (NMEC - 2)	One Course from Outside Department	2	2	3	30	70	100
	Internship / Industrial Activity @			2		20	80	100
	Total		30	23	-	-	-	700
IV	Core Course - 7 (CC - 7)	Economic Geology	6	4	3	30	70	100
	Core Course - 8 (CC - 8)	Hydrogeology	6	4	3	30	70	100
	Core Course - 9 (CC - 9)	Geoexploration and Mining Geology	6	4	3	30	70	100
	Discipline Centric Elective Course - 4 (DCEC - 4)	Any one from the list	4	4	2	30	70	100
	Entrepreneurship / Industry Based Course @	Gemology	3	3	3	30	70	100
	Project Work @		5	5	-	20	80	100
	Value Added Course – 2 (VAC -2)*	Instrumentation Techniques in Geology	-	2*		30	70	100*
	Total		30	24	-	-	-	600
	Grand Total			91				2600

LIST of DISCIPLINE CENTRIC ELECTIVE COURSE (DCEC)

Discipline Centric Elective Course - 1 (DCEC - 1)	
1.	Geomorphology
2.	Micropalaeontology
Discipline Centric Elective Course - 2 (DCEC - 2)	
1.	Engineering Geology
2.	Quaternary Geology
Discipline Centric Elective Course - 3 (DCEC - 3)	
1.	Mining Geology
2.	Medical Geology
Discipline Centric Elective Course - 4 (DCEC - 4)	
1.	Fuel Geology
2.	Petroleum Exploration and Mud logging

LIST OF NON-MAJOR ELECTIVE COURSE (for other Department Students only)

Sl. No.	Non-Major Elective Course (NMEC)
1.	Introduction to Minerals, Rocks and Fossils
2.	Geology for Competitive Examinations-I

LIST OF GENERIC ELECTIVE COURSE (GEC)

GENERIC ELECTIVE COURSE - 1 (GEC - 1)	
1.	Oceanography
2.	Climatology
3.	Climatic Change Studies
GENERIC ELECTIVE COURSE - 2 (GEC - 2)	
1.	Environmental Geology
2.	Geo techniques
3.	Isotope Geology
GENERIC ELECTIVE COURSE - 3 (GEC - 3)	
1.	Remote Sensing and GIS
2.	Remote Sensing applications in Geosciences
3.	Introduction to Artificial Intelligence and Machine Learning

SUMMARY OF CURRICULUM STRUCTURE OF M.Sc. GEOLOGY

Sl. No.	Types of the Course	No. of Courses	Credits for each Course	Total Credits	Marks
1.	Core Course	9	4	36	900
2.	Core Practical	3	4	12	300
3.	Discipline Centric Elective Course	4	4	16	400
4.	Generic Elective Course	3	3	9	300
5.	Skill Enhancement Course	2	2	4	200
6.	Non-Major Elective Courses	2	2	4	200
7.	Internship / Industrial Activity @	1	2	2	100
8.	Entrepreneurship/ Industry Based Course @	1	3	3	100
9.	Project @	1	5	5	100
Total		26	-	91	2600
Value Added Courses *		2*	2	4*	200*

*	The value added courses credit will not be included in the total CGPA. These courses are extra-credit courses. Instruction hours for these courses is 30 hours								
@	Summer Internship will be carried out during the summer vacation after the First year. Viva Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 3rd semester Mark Statement. Summer Internship / Industrial Activity & Project Scheme of Evaluation: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Description</th><th>Marks</th></tr> </thead> <tbody> <tr> <td>Report</td><td>80</td></tr> <tr> <td>Viva</td><td>20</td></tr> <tr> <td>Total</td><td>100</td></tr> </tbody> </table>	Description	Marks	Report	80	Viva	20	Total	100
Description	Marks								
Report	80								
Viva	20								
Total	100								

First Year

**CORE COURSE I
GEOTECTONICS AND STRUCTURAL GEOLOGY**

Semester: I

Code:

(Theory)

Credit: 4

COURSE OBJECTIVES:

- To study in detail on origin of earth and its structure
- To get an idea on structural and tectonic features
- To understand the mechanical principles of rock deformation
- To understand the modes of representation of rock structure
- To know about the petro fabric analysis

UNIT-I:

Geotectonics: Study of seismic waves – structure and composition of the earth – Radioactivity – radiometric dating. Volcanism – Volcanic zones of the earth. Major tectonic features of the earth-shield areas, mobile, zones, rift Valleys, mid oceanic ridges, continental shelf and slopes, submarine Canons.

UNIT-II:

Geosynclines, Isostasy, Island arcs, deep Sea trenches, continental drift, plate tectonics and sea floor spreading. Orogeny and orogenic cycles – Epeirogeny and evolution of plateaus. Structural and tectonic features of India. Quaternary tectonics

UNIT-III:

Structural geology: mechanical principles – three stages of rock deformation – elastic, plastic and rupture. Concept of stress, strain and the resulting ellipsoids. Mechanics of plastic and ruptural deformation. Factors controlling behavior of rock material. Folds – Brief resume of terminology, Classification and description – Recognition, mechanics and causes of folding-Recognition of top and bottom of beds.

UNIT-IV:

Faults – Description, classification, recognition criteria and mechanics of faulting. Joints in Quantitative and qualitative classification of joints. Modes of representation of joints – Histograms, Rose diagrams and preparation of stereograms. Unconformity types, recognition, significance, distinction from faults and their use in dating structural events.

UNIT-V:

Cleavage, Schistosity and Lineation – their description, origin and relation to major structures. Petrofabric analysis – Field and laboratory techniques – petrofabric diagrams and their interpretation. Classification and characteristics of Tectonites, Diapirs and related structural features. Writing of field Geological report.

UNIT–VI CURRENT CONTOURS

(For Continuous Internal Assessment Only):

To discuss about Neotectonics and its impacts

COURSE OUTCOMES:

- Give an idea about the various structural features associated with different tectonic process
- Structural Geology will help to find out the engineering problems mainly in the case of Dams, Reservoirs, bridges, roads
- Describe the nature and principles of plate tectonics and related crustal deformation.
- Critically evaluate the evidence for the operation of plate tectonics, e.g. in the Archaean Superior and Nain Provinces, in the Palaeoproterozoic Lapland-Kola Orogen, Lewisian Complex and Svecofennian Province and in the Meso-to Neoproterozoic of Laurentia-Baltica.
- Discuss about the different stages of rock deformation, origin of different natural hazards.
- Describe the main tectonic features and processes associated with a selection of orogenic belts.
- To demarcate the underground water resources.
- Able to understand the concept of hydraulic conductivity and hydraulic head sufficiently in order to construct a water table map and interpret the basic physics of groundwater flow based on a water table map.

REFERENCES:

1. Billing, M.P. (1974) – Structural Geology, Prentice Hall
2. Hobbs, R.F. et al. 1976 – An outline of structural geology, Wiley
3. Hills, E.L. 1965 – Elements of Structural Geology, Asia Publication House.
4. Belousov, V.V. 1954 – Basic problems in Geotectonics, McGraw Hill.
5. De Sitter, L. 1956 – Structural geology, McGraw Hill
6. Navin, C.M. 1953 – Principles of Structural Geology, Wiley.
7. Lahee, H. 1959 – Field Geology, McGraw Hill.
8. Ragan, D.M. – 1973 – Structural Geology, Wiley
9. Ramsay, J.G. 1967 – Folding and fracturing of Rocks. McGraw Hill
10. Philips, F.C. 1954 – The use of Stereographic projection in Structural Geology, Arnold Publishers
11. Compton, R.R. – 1962 – Manual of field geology, Wiley
12. Allan Cox 1973 – Plate tectonics, Freeman & Co.
13. Ajitksil, 2018, Geotectonics and geomorphology vol 1, The Himalayan books
14. Tarling, 1981, Economic Geology and geotectonics, Halstead Press
15. Palmer and Redw, 2022, Structural Geology tectonics, Oxford book company
16. Hatcher, Robert and Christopher Bailey, 2019, Structural Geology, principles, concepts and problems, Oxford university press
17. Pearson, 2017, Basic methods of structural geology, Pearson education

First Year

**CORE COURSE 2
PALAEOLOGY**

Semester I

Code:

Credit:4

COURSE OBJECTIVE:

- To acquire knowledge on geological significance of fossils.
- To understand the concept of evolution
- To know the stratigraphic importance of different fossils
- To understand the Vertebrate evolution through Geological Time
- To study the importance of applications of Microfossils.

UNIT-I:

Fossilization and fossil record Fossil-definition and conditions of fossilization; Mode of preservation and geological significance of fossils.

UNIT-II:

History of the concept of evolution – Pre-formation theory; Baer's law; Biogenetic law; Lamarckism; Darwinian principles- Natural, Sexual and artificial selections; Theory of pangenesis; Mutation theory; Orthogenesis; Isolation.

UNIT-III:

Detailed morphology, evolution and stratigraphic importance of the following groups. Corals, Graptolites, Trilobites, Brachiopods and Ammonites. Evolution of plants through ages – Gondwana flora and their stratigraphic significance.

UNIT-IV:

Principal groups of vertebrates through geologic time – Devonian fishes and Mesozoic reptiles. Evolutionary histories of Horse, Elephant and Man.

UNIT-V:

Types of microfossils – General morphology, Stratigraphic, ecological and palaeoecological significance of foraminifera, Ostracoda and spores and pollens – Procedures for Sampling and separation of microfossils. Use of micropalaeontology in environmental, oil and marine studies.

UNIT -VI: CURRENT CONTOURS (For Continuous Internal Assessment only):
Recent researches in Stratigraphic studies.

COURSE OUTCOMES:

- Acquisition of concepts related to fossilization and its significance.
- Gaining Knowledge about concept of evolution.
- Acquisition of knowledge on stratigraphic importance of invertebrates.
- Understood about types and importance of microfossils.

REFERENCES:

1. Woods,H.1959–Invertebrate Palaeontology, Cambridge.
2. Romer, A.S. 1960– Vertebrate Palaeontology, Chicago press.
3. Amold,C.A.–1947–An introduction to palaeobotany.
4. Shrock.R.R. and Twenhofel,W.H–1953–Principles of invertebrate Palaeontology, Amold publication
5. Moore, R. C. Lalieker, C.D. and Fischer,A.G–1952–Invertebrate Fossils McGraw Hill.
6. Jones.D.J–1958–An introduction to Microfossils, Harper brothers
7. G. Bignot (1985)-Elements of Micropalaeontology GrahamTrotman,1985.
8. B.U.Hag and A. Boersma (1978)Introduction to Marine Micropalaeontology. Elsevier, Netherlands, 376 P.
9. Davidbainbridge, 2022, paleontology and illustrated history, Princeton university press
10. Charleseastman, 2020, textbook of paleontology, alphaeditions
11. David harper and Michael benton,1997,basic palaeontology, prentice hall
12. Michaelbenton,
2019,dianosarusrediscover.thescientificrevolutioninpaleontology, thames and Hudson.

First Year

**CORE PRACTICAL I
PALAEOLOGY, STRUCTURAL GEOLOGY
AND SURVEYING**

Semester I

Code:

Credit 4

COURSE OBJECTIVES:

- To study the evolutionary characteristics of different fossils in hand specimens.
- To study the preparation structural setup.
- To understand the techniques involved in Satellite data interpretation.

PALAEOLOGY:

Macroscopic study of corals, Graptolites, Trilobites, Brachiopods, Lamellebrachia, Gastropods, Ammonites and Echinoderms with special reference to their evolutionary characters. Study of plant fossils. Microscopic study of some forms and ostracods.

STRUCTURAL GEOLOGY:

Interpretation of complex geological maps, study of actual field geological maps; problems relating to depth and thickness; use for stereographic projection for solution of problems in structural geology. Borehole problems involving determination of attitude of tabular bodies (interpretation of lithological data from inclined boreholes, preparation of Latitudinal vertical sections measurement of bore hole deviations.)

SURVEYING:

Determination of heights and distance using Total station - Determination of area using Total station - Traversing using Total station - Determination of height(s) using Auto levelling - Traversing using Plane table surveying - GPS / GNSS survey

Current Contours (For Continuous Internal Assessment only):

New mapping tools and Hyperspectral remote Sensing.

COURSE OUTCOMES:

- Hands-on exercise to identify fossils
- Hands-on exercise to find out trends of rocks strata
- Hands-on exercise of topographic sheets and satellite images
- To understand the interpretation of Remote Sensing data,
- To get idea on different structures in the field and map
- Able to understand the scope and importance of microfossils
- To know how to identify fossils and which are the utilities of Palaeontology

First Year

DISCIPLINE CENTRIC ELECTIVE COURSE - 1

Semester I

1. GEOMORPHOLOGY

Code:

Credit 4

COURSE OBJECTIVES:

- To study landform formation, physiography of the Earth, exogenous and endogenous geomorphic processes,
- To learn the processes of landforms formed due to weathering, soil formation, erosion, transportation and deposition processes.

Unit 1: Geomorphology – Introduction: Fundamental concepts of Geomorphology – Fundamental driving forces of landform formation: internal and external forces – Energy balance of the Earth's surface processes – Physiography of the Earth – Outline of geomorphic processes: exogenous and endogenous processes – Applications of Geomorphology.

Unit 2: Weathering, Soil and Drainage: Weathering: types and products, factors affecting rates of weathering, landforms formed by weathering, applications – Soils: soil development process, factors affecting soil production, soil profiles, soil classification, soils and landscapes, – Erosion, transportation and deposition of Earth materials – Hill slopes: processes, climatic influence on slope processes, slope morphology, and slope evolution, applications – Drainage: patterns, evolution, quantitative analysis.

Unit 3: Fluvial, Glacial, Groundwater, Aeolian Geomorphology: Fluvial Geomorphology: fluvial processes and landforms, applications of fluvial geomorphology – Glacial Geomorphology: glacial processes and landforms, applications – Groundwater Geomorphology: processes, landforms, and applications – Aeolian Geomorphology: aeolian processes, landforms, applications.

Unit 4: Tectonic and Volcanic Geomorphology, Landforms related to Rock Type and Structure: Tectonic Geomorphology: tectonic processes, landforms and landscape response to tectonics, markers of tectonic geomorphology, applications – Volcanic Geomorphology: volcanic landscapes, processes of volcanic landform evolution, applications – Landforms related to rock type and structure - Outline on impact craters – Anthropogenic activities and landforms

Unit 5: Coastal, Marine, Climatic Geomorphology and Geomorphology of India: Coastal Geomorphology: coastal processes and landforms, applications – Shorelines: classification of shorelines and their evolution – Marine Geomorphology: marine processes and landforms, applications – Climatic Geomorphology: records of changing climate cycles, Koppen climate classification, climate related landform and processes, landscape response to climate, landscape controls on climate, applications – Major geomorphic features of India: coastal, peninsula and extra peninsula – River basins of India.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Fundamental concepts of Geomorphology, landform formation, physiography of the Earth, exogenous and endogenous geomorphic processes.
2. Processes and landforms formed due to weathering, soil formation, erosion, transportation and deposition processes, hill slope processes, drainage development
3. Processes and landforms formed due to the action of river, glaciers, wind, tectonism and volcanism
4. Processes and landforms formed due to the action of coastal, marine, climate and anthropogenic activities.
5. Processes and landforms related to rock type and structure
6. Major geomorphic features of India and river basins of India

Text Books:

1. **Dayal, P (2010).** A Text Book of Geomorphology, Rajesh Publications.
2. **Kale, V and Gupta, A. (2018).** Introduction to Geomorphology, Universities Press, Orient Black Swan Pub.
3. **Kale, V. (2014).** Landscapes and Landforms of India, Springer.
4. **Plummer, C.C., Carlson, D.H and Hammersley, L. (2016).** Physical Geology (XV Edition), McGraw-Hill Education.
5. **Savindra Singh (2018).** Geomorphology, Prayag Pustak Bhawan.
6. **Sharma, H.S. (2010).** Geomorphology in India, Prayag Pustak Bhawan.
7. **Siddhartha, K. (2018).** The Earth's Dynamic Surface: A Book of Geomorphology (Paperback), Books Wagon Pub.
8. **Thornbury, W.D. (2018).** Principles of Geomorphology (III Edition), New Age International Publishers.
9. **Vaidyanathan, R. (2002).** Geomorphology of the Indian Subcontinent, Published by the Indian Society of Remote Sensing.

Reference Books:

1. **Adrian Harvey. (2012).** Introducing Geomorphology: A Guide to Landforms and Processes, Dunedin Academic Press Ltd.
2. **Ahnert, F. (1998).** Introduction to Geomorphology, Routledge Publishers, New Delhi, 360p.
3. **Bierman, P.R and Montgomery, D.R. (2014).** Key Concepts in Geomorphology, W. H. Freeman & Co.
4. **Burbank, D.W and Anderson, R.S. (2008).** Tectonic Geomorphology, Blackwell Science Ltd.
5. **Gutierrez, M. (2005).** Developments in Earth Surface Processes: Climatic Geomorphology, Elsevier Pub.
6. **Rugget, R.J. (2017).** Fundamentals of Geomorphology (Fourth Edition), Routledge Pub.
7. **Summerfield, M A. (1991).** Global Geomorphology, Pearson Educational, for Prentice Hall.
8. **Tarback, E.J and Lutgens, F.K. (2014).** Earth – An Introduction to Physical Geology, Pearson Education.

First Year

DISCIPLINE CENTRIC ELECTIVE COURSE - 1

Semester I

2. MICROPALAEONTOLOGY

Code :

Credit 4

COURSE OBJECTIVES:

- To focus on microfossils and their significance in stratigraphy, paleoecology, and petroleum exploration.
- It covers the morphology, classification, ecology, and geological applications of various microfossil groups
- To study integrates sampling, processing techniques, and applications of microfossils in environmental and resource studies.

Unit 1: Introduction to micropaleontology – Historical development of micropaleontological studies: world-wide in general and India in particular – Surface and sub-surface sampling methods, processing of samples, preparation of thin sections of larger foraminifera – Sampling techniques for ecological studies living microforms – Scanning Electron Microscope (SEM) photographic techniques.

Unit 2: Test morphology, wall structure, dimorphism, classification, evolution and ecology/paleoecology of foraminifera – Biometrics of important larger foraminifera – Stratigraphy of foraminifera with emphasis on Indian stratigraphic horizons.

Unit 3: Carapace morphology, ecdysis, scatter diagrams (Ontogenic studies), classification, evolution and ecology/paleoecology of Ostracoda – Applications of functional morphological characteristics in environmental studies, Carapace/valve ratio, adult/juvenile ratio, predation and pyritisation of carapace to interpret paleoecology and hydrocarbon potential – Morphology, mineralogy and geological distribution of nanno fossils.

Unit 4: Skeletal morphology, wall structure, classification, palaeoecology and palaeoceanography of Radiolaria – Morphology and classification of Conodonts, Bryozoa – Outline of Silicoflagellates and dinoflagellates.

Unit 5: Diatoms and Pteropods – Palynological techniques, morphology, distinguishing characteristics of spores and pollen and their uses in oil industry – Applications of microfossils: biostratigraphical, paleoecological, paleobiogeographical and economical (hydrocarbon and coal) uses – Divisions of the marine environment and their characteristic fauna and flora.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The fundamentals and historical development of micropaleontology.
2. The morphology, classification, and paleoecological significance of different microfossil groups.
3. Sampling techniques, processing, and preparation of microfossil samples.

4. Role of microfossils in stratigraphy, paleo environmental reconstruction, and resource exploration.
5. Industrial applications of micropaleontology, particularly in hydrocarbon and coal exploration.

Text Books:

1. **Amaldas Gupta (2016).** An Introduction to Palaeontology, World Press Pvt. Ltd.
2. **Bignot, G (1985).** Elements of Micropalaeontology, Graham Trotman.
3. **Clarkson, E and N.K. Clarkson (1998).** Invertebrate Palaeontology & Evolution, Wiley-Blackwell.
4. **Doyle, P (1996).** Understanding Fossils: An Introduction to Invertebrate Palaeontology, John Wiley & Sons Ltd.
5. **Jain P.C and M.S. Anatharaman (2018).** An Introduction to Paleontology, Vishal Publications.
6. **Raup, D.M and S.M Stanley (1985).** Principles of Paleontology, CBS Publications.
7. **Saraswati P. K and M.S. Srinivasan (2016).** Micropaleontology - Principles and Applications, Springer International Publishing.
8. **Sreepat Jain (2017).** Fundamentals of Invertebrate Palaeontology, Springer.
9. **Woods, H (1959).** Invertebrate Palaeontology, Cambridge.

Reference Books:

1. **Armstrong Howard, A and D. B. Martin (2005).** Microfossils, Blackwell Publishing.
2. **Benton, M. J (2015).** Vertebrate Palaeontology and Evolution (IV Edition), Wiley-Blackwell.
3. **Colbert, E.M (1960).** Evolution of the Vertebrates, Wiley Eastern.
4. **Easton, W. H (1960).** Invertebrate Paleontology, Harper's Geoscience Series,
5. **Hag, B.U and A. Boersma (1978).** Introduction to Marine Micropalaeontology. Elsevier.
6. **Moore, R.C., Lalieker, C.D and A.G. Fischer (1952).** Invertebrate Fossils, McGraw Hill.
7. **Prothero, D. R (2007).** Evolution - What the Fossils Say and Why it Matters? Columbia University Press.
8. **Reed Wicander and J. S. Monroe (2007).** Historical Geology: Evolution of Earth and Life through Time (VI Edition), Brooks / Cole, Cengage Learning.
9. **Romer, A.S (1960).** Vertebrate Palaeontology, Chicago Press.
10. **Shrock, R.R and W.H Twenhofel (1953).** Principles of Invertebrate Palaeontology, Arnold Publications.

First Year

**GENERIC ELECTIVE COURSE - 1
1. OCEANOGRAPHY**

Semester I

Code

Credit: 3

Course Objectives:

- To learn about about the ocean morphology, processes, classification and marine resources.
- To understand the various dimensions of oceans, its structure and all aspects related to it.
- To understand the chemistry and its composition of marine water, various marine pollutants and its ecological impacts.

Unit 1: History of development of Oceanography – Origin of seas and oceans –. Ocean morphology, deep ocean floor and various topographic features, ridges, seamounts, coral reefs, continental shelf, slope, benches and canyons – Hydrothermal vents and seawater-basalt interaction.

Unit 2: Oceanic circulation, waves, currents and tides- T-S diagrams: mixing processes in the oceans – Characteristics of important water masses – Wind generated waves in the oceans: their characteristics; shallow and deep-water waves – Propagation, refraction, and reflection of waves – Wave spectrum, principles of wave forecasting– Nearshore geological processes, sea level changes with special emphasis on Quaternary-Oceanic sediments and distribution of marine microfossils – Stratigraphy and geochemistry of deep-sea deposits.

Unit 3: Tectonic history of the oceans – Tectonics of continental margins, continental shelves, divergent margins, active margins and marginal basins – Global tectonics and seafloor spreading – Chemical properties of sea water –Chemistry of oceanic rocks – marine instrumentation on navigation with special mention on geological studies such as dredges, grabs, water samplers, underwater cameras, etc.

Unit 4: Mineral resources of the oceans – Diagenetic changes in oxic and anoxic environments – Mobility of redox metals – Isotope geochemistry and paleoceanography – Sedimentary markers (biological and chemical) of palaeoenvironmental conditions – Paleoceanography – Approaches to paleoceanographic reconstructions: various proxy indicators for paleoceanographic interpretation – Reconstruction of monsoon variability by using marine proxy records – Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic – Sea level processes and sea level changes.

Unit 5: Hydrocarbons beneath the sea floor – Marine gas hydrates and their economic potential – Ocean laws and management – Marine pollution-Deep-sea drilling projects and modern research in marine geology – Marine geology of Antarctic sea and other cold seas/oceans.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The origin, evolution, and morphology of oceans and associated topographic features.
2. Oceanic circulation, wave dynamics, sedimentation processes, and sea-level changes.
3. Tectonic history and chemical properties of sea water and oceanic rocks.
4. Marine resources, paleoceanographic reconstructions, and geochemical proxies for environmental interpretation.
5. Hydrocarbon resources, marine gas hydrates, marine pollution, and ocean management
6. Interpretation of marine geological data using tools such as seismic profiles, bathymetric maps, and core samples to assess oceanographic and environmental processes.

Text Books:

1. **Grant Gross, M. (1977).** Oceanography; A view of the Earth, Prentice Hall.
2. **Kennet, J.P., (1982).** Marine Geology, Prentice Hall.
3. **Pinet, P.R. (2019).** Invitation to Oceanography. Jones & Bartlett Learning.
4. **Ross, D.A. (1982).** Introduction to Oceanography, 3rd Edition, Prentice Hall.
5. **Seibold, E. and Berger, W.H., (1982).** The Sea floor, Springer-Verlag.

Reference Books:

1. **King, C.A.M (1975).** Introduction to marine Geology and Geomorphology. Edward Arnold.
2. **Shepard, F.P (1978).** Geological Oceanography, Heinmann.
3. **Savindra Singh, (2020).** Oceanography, Pravalika Publications.
4. **Svedrup, J.F (1969).** The Ocean, A Scientific American book, W.H. Freeman and company.
5. **Weisberg, C.P (1979).** Oceanography. McGraw Hill.
6. **Komar, P.D. (1976).** Beach processes and sedimentation, Prentice Hall.

First Year

GENERIC ELECTIVE COURSE - 1
2. CLIMATOLOGY

Semester I

Code

Credit 3

COURSE OBJECTIVES:

- To understand Earth's climates and the factors that influence and control them
- To understand the structure, composition and interaction of Atmosphere
- To know how they operate and change over time, and applications of climatology.

UNIT – I:

Introduction Climatology - Definition – Branches – Nature, Scope and Trends and Development – Atmosphere – Composition and Structure – Insolation, Heat Budget: Mechanisms of Heat Energy Transfer – Heating and Cooling of Atmosphere and Earth – Distribution of Temperature – Horizontal and Vertical Distribution – Temperature Inversion and Albedo.

UNIT – II:

Atmospheric Pressure and Winds: Pressure Gradient and Variations – Vertical , Horizontal and Seasonal Variation of Air Pressure, Winds: Factors affecting Wind Motion – Geostrophic Wind – Gradient Wind – Wind Measurement – Beaufort Scale – Models of General Circulation of Atmosphere: Surface Wind System – Latitudinal Shifting of Wind Belts – Jet Stream – Monsoon – Concepts Of Origin Of Monsoon – Indian Monsoon, Local Winds.

UNIT – III:

Precipitation – Humidity – Definition – Types – Factors affecting Potential Evapotranspiration and Actual Evapo-Transpiration – Dew Point – Atmospheric Equilibrium: Stability and Instability – Adiabatic Process – Temperature Change – Condensation – Forms of Precipitation – Clouds – Mean Annual Precipitation – Variability – Intensity – Artificial Precipitation.

UNIT – IV:

Air masses and Fronts: Definition and Characteristics – Source Regions – Classification. Atmospheric Disturbances: Cyclones and Anticyclones - Temperate Cyclones- Tropical Disturbances, Movement and Track.

UNIT – V:

Climatology – Koppen – Thornthwaite – Trewartha Classification, Climatic System And Changes – Natural and Anthropogenic Causes, Weather Forecasting – Methods And Trends, Agro Climatology: Elements – Heat Island – Air Pollution – Green House Effects – Ozone Depletion – Human Comfort Zones.

UNIT VI- Current Contour (For continuous internal assessment only): Climate Change and Global Warming, UN frame work Convention on Climate Change, Climate Justice and Equity, Global Warming and Population, Dominance and Change in Artic, Global Dimming.

COURSE OUTCOMES:

- Understood the nature of climatology and its banches.
- Got the idea of atmospheric pressure and its mechanics
- Understood the concepts of monsoon

REFERENCES:

- Lal, D.S. (1996), Chaitanya Publishing House, Allahabad.
- Collings, V.K. (1987), Weather, Radar and Flood Forecasting, John Wiley & Sons, New York.
- Critchfield, H.J. (1996), General Climatology, Prentice Hall, New Jersey.
- Menon, P.A. (1989), Our Weather, National Book Trust, New Delhi.
- Smith, K., (1975), Principles of Applied Climatology, McGraw Hill Book Co., London.
- Trewartha, G.T., (1968), An Introduction to Climate, McGraw Hill BooK Co., New York.
- T.R. Oke, G. Mills, A. Christen and J.A. Voogy, Urban Climates, Cambridge University Press; 1 edition, 2017.
- Lutgens, Frederic K. & Tarbuck, Edward J. (2010). The Atmosphere: An Introduction to Meteorology. New Jersey: Pearson Prentice Hall.
- Oliver, John E. & Hidore, John J. (2003). Climatology: An Atmospheric Science. Delhi: Pearson Education.
- Singh, S. (2005). Climatology. Allahabad: Prayag Pustak Bhawan.
- <https://swayam.gov.in/course/4242-physical-geography-ii-climatology-oceanography>
- <https://www.britannica.com/science/climatology> 13. <https://www.ncdc.noaa.gov/>

First year

GENERIC ELECTIVE COURSE - 1
3. CLIMATE CHANGE STUDIES

Semester I

Code

Credit 3

COURSE OBJECTIVES:

- To learn the fundamentals of climate systems, climate processes, paleoclimatology, natural climate variability, and anthropogenic climate change.
- To understand the climate dynamics, past climate evidence, and future climate projections, integrating both natural and human-induced factors influencing climate change.

Unit 1: Fundamentals of Climate: Solar spectrum and Earth's radiation balance; latitudinal and seasonal variation of temperature, pressure, air density, humidity – Constitution and stratification of the Earth's atmosphere – Global ocean circulation – Water cycle – Classification of current climates: Koppen's and Thornthwaite's scheme of classification

Unit 2: Climate Processes: Earth's energy imbalance and energy flow – Radiative forcing – Rising Temperature – Solar irradiance – Greenhouse effect – Carbon-dioxide and carbon – Climate forcing, and climate feedbacks – Earth's atmosphere – Earth's land surface – The world ocean – Cryosphere and melting ice – Ocean-Atmosphere Interface – Land-Atmosphere interface.

Unit 3: Paleo climatology: Principles of Paleoclimatology – Causes of climate change – Multidisciplinary approach in Paleoclimatology – Proxies of palaeoclimate, Paleo-atmospheres: Ice-core record – Paleo-sea level: Sediment core record – Biological concepts in Paleoclimatology.

Unit 4: Natural Climate Change: Orbital climate change and geologic evidence – Millennial-scale climate change, Holocene climate change, Centennial climate change and Decadal climate change – Inter annual climate change in the Tropics: ENSO – Ice core record of climate change: glacial, interglacial climate and climate proxies from ice cores - Sea-level change: historical sea-level and evidence for Sea-Level Change – Role of volcanoes in climate change.

Unit 5: Anthropogenic Climate Change: Human activities impacting the climate system – Fossil fuel, atmospheric change, land use – Ocean acidification – Rising sea level – Melting glaciers – More violent storms – Deforestation – Desertification – Species migration and extinctions – Changing seasons and disruption of life cycles – Projections of future climate – Intergovernmental Panel on Climate Change and Summary of the latest assessment report.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The fundamental principles of climate systems and their classification.
2. Climate processes, energy balance, and climate feedback mechanisms.
3. Methods and proxies used in paleoclimatology.
4. Natural causes of climate variability across different timescales.
5. The impacts of human activities on climate and future climate scenarios.
6. Latest climate change assessment report of the IPCC

Text Books:

1. **Mcilveen, J.F.R (1992).** Fundamentals of Weather and Climate, Springer-Science Business Media.
2. **Ralph J. C (2001).** Climate Change Science, National Research Council.
3. **Thomas Farmer, G (2015).** Modern Climate Change Science: An Overview of Today's Climate Change Science, Springer.
4. **Trevor Letcher (2009).** Climate Change, Elsevier Science.

Reference Books:

1. **Asheem Srivastav (2019).** The Science and Impact of Climate Change, Springer.
2. **Fátima Alves, Walter Leal Filho and Ulisses Azeiteiro (2018).** Theory and Practice of Climate Adaptation, Springer International Publishing.
3. **James Rodger Fleming (1998).** Historical Perspectives on Climate Change, Oxford University Press.
4. **Lamb, H. H (2006).** Climate: Present, Past and Future: Volume 1 - Fundamentals and Climate Now, Routledge (Taylor & Francis Group).
5. **Michael D. Mastrandrea, Stephen H. Schneider (2010).** Preparing for Climate Change, The MIT Press.
6. **Thomas M. Cronin (1999).** Principles of Paleoclimatology, Columbia University Press.

First Year

**SKILL ENHANCEMENT COURSE-I
GEOLOGY AND MINERAL RESOURCES OF TAMIL NADU**

Semester I

Code:

Credit 2

COURSE OBJECTIVES:

- To study about various Geological Structures.
- To understand causes and effects of Tectonics.
- To study about different Mineral occurrences and its Economic importance.

Unit –I Structure and tectonics, Shear zones, folds, faults and lineaments in Tamil Nadu. Rivers and Soil types of Tamil Nadu. The Western and Eastern Ghats of Tamil Nadu and their structural aspects. Archaean and Proterozoic: An outline of Sathyamangalam group of central and NW Tamil Nadu. An outline of anorthosites of Sittampoondi, Kadavur and Oddanchatram, Peninsular gneissic complex (Bhavani group), Kolar group, Khondalite group with emphasis on Cordierite-sillimanite rocks of Trichy and Madurai regions, Charnockite group with emphasis on charnockites of Pallavaram, Granites of central and southern Tamil Nadu.

Unit -II Palaeozoic sediments: An outline of Talchir formation of Palar basin. Mesozoic sediments – An outline of Upper Gondwana rocks of Terani and Uttattur. An outline on marine Cretaceous formations of Trichirapalli, Virudhachalam and Pondicherry sub-basins. Tertiary sediments: An outline on Niniyur formation, Cuddalore Sandstone. Neyveli formation. Panamparai sandstone

Unit-III Quaternary sediments: An outline on Pliocene rocks of Kambam valley, Conjeevaram gravels, Pleistocene rocks along the coastal tracts of Tuticorin district and laterite deposits of Eocene (Shevroy, Kollimalai, Anaimalai, Nilgiri, Palani and Kodaikanal) and Mio-Pliocene (Pudukkottai, Ramanathapuram and Cuddalore).

Unit –IV Descriptive study related to origin, mode of occurrence and use of iron ores of Kanjamalai and Kavuthimalai, Chromite and PGE of Sittampoondi, Magnesite deposits of Chalk hills, Bauxite deposits of Shevroy hills, Graphite beds of Sivaganga.

Unit- V Lignite deposits of Neyveli and Jayamkondam, Beach placer deposits of southern Tamil Nadu. Mode of occurrence and distribution of precious and semi-precious stones in Tamil Nadu

COURSE OUTCOMES:

- Students would gain a holistic knowledge on various structural elements and tectonics of Tamil Nadu;
- The geology, structure, faunal content and economic importance of geological formations distributed across Tamil Nadu

Reference and Textbooks:

- Krishnan, M. S. (2004). Geology of India and Burma, CBS Publishers and distributors, New Delhi.
- Krishnan, M. S. (2017). Geology of India and Burma. CBS Publishers and distributors.
- Selvam, T.A. & Subramanian, (2002). Geology of Tamil Nadu & Pondicherry. Bangalore: Geological Society of India Publication.

First Year

**VALUE ADDED COURSE I
GEOSTATISTICS**

Semester: I

Code:

Credit:2

COURSE OBJECTIVES:

- To introduce the basic concepts of statistics to the students.
- To understand the purpose, meaning, and use of statistics.
- To apply statistical techniques to solve the given problems.

UNIT – I:

Concepts–Definition–Merits and limitation– Tabular and diagrammatic Illustration: Bar diagram and pie diagram– histogram and frequency polygon–ogives; Measures of central tendency.

UNIT–II:

Mean, Median, Mode, Dispersion–standard deviation–skewness, kurtosis–Karl Pearson's coefficient of Skewness; Correlation and Regression- concepts, Karl Pearson's coefficient of correlation – Rank correlation

UNIT – III:

Regression lines of regression; Probability–Meaning and Uses Addition and Multiplication theorems– Bayesian rule - A brief note on statistical software.

UNIT–IV:

Distribution of sample variance and chi square distribution; probability; testing normal distribution; students 't' test, 'f' test; confidence interval, analysis.

UNIT–V:

Calculation of variance- covariance, simple linear models; cluster analysis. Applications of Statistics in Geosciences.

Course Outcome:

Familiarizes the properties of parametric, semi-parametric and non parametric testing procedures. Interpret and communicate the results from statistical analysis.

REFERENCES:

1. Ajai,S.G.andSanjaya,S.G.(2009)Statistical Methods for Practice and Research, Sage Publications, New Delhi.
2. Andy Field (2013) Discovering Statistics Using IBM SPSS Statistics, 4th Edition, Sage Publications, London.
3. Dennis D. Boos (2013). Essential Statistical Inference: Theory and Methods, Springer Science & Business Media.
4. Ding-Geng (Din)Chen, Karl E. Peace (2021) Applied Meta- Analysis with RandStata.
5. GeorgeA.Morgan (2011).IBMSPSS for Introductory Statistics, Taylor& Francis.
6. LymanOtt(2015) .An Introduction to Statistical Methods and Data Analysis, Cengage Learning.

First Year

CORE COURSE III
ADVANCED CRYSTALLOGRAPHY AND
MINERALOGY

Semester II

Code

Credit 4

COURSE OBJECTIVES:

- To study about crystal classes and projection types
- To know about the irregularities in crystals
- To understand about formations of different crystal systems
- To know about mineral formation
- To understand the optical properties of different minerals

Unit 1: Advanced Crystallography: Derivation of 32 Crystal classes and their symmetry projections – Hermann mauguin notation – Stereographic and gnomonic projections of crystals belonging to normal classes – 14 Bravais space lattices – X-ray Crystallography: Derivation of Bragg's law and its applications, Powder diffraction method, Powder diffractometer – Monochromatic radiations – Space lattice- unit cell-motif-point, group-space group – Concepts of crystal field theory and mineralogical spectroscopy – Stoichiometry – Atomic substitution in minerals – Lattice defects (point, line and planar).

Unit 2: Optical mineralogy: Polarization – Double refraction in calcite – Nicol prism – Polarizing microscope and Its accessories (quartz wedge, mica plate, gypsum plate, berek compensator, micrometer ocular) and their uses –Orthoscopic and conosopic study of minerals – Ray velocity surface of uniaxial and biaxial minerals – Optic axis: primary and secondary optic axes – Indicatrix: uniaxial and biaxial minerals – Interference figure, sign of elongation, optic sign – Methods of determination of refractive indices of minerals.

Unit 3:Optical properties of uniaxial and biaxial minerals – Mineral orientation, dispersion, pleochroic scheme, birefringence, twinning, extinction angle – Determination of optic sign using interference figures, sign of elongation and optic axial angle – Optical anomalies and irregularities in minerals – U stage techniques for determination of anorthite content and twin laws in plagioclase.

Unit 4: Descriptive mineralogy: Classification of minerals – Physical properties of minerals– Mineral properties: Isomorphism, polymorphism, pseudomorphism, exsolution, order and disorder relations, fluorescence in minerals – Thermoluminescence study and its significance – Metamict state, staining techniques and micro chemical tests – Structural classification of silicate minerals and their compositional variations – Optical properties, physical properties and paragenesis of the following mineral groups: olivine, pyroxene, amphibole, mica, chlorite, halide and clay.

Unit 5: Optical properties, physical properties and paragenesis of the following mineral groups: Quartz, feldspar, feldspathoid, zeolites, garnet, epidote, spinel, alumino-silicates – Optical

properties, physical properties and paragenesis of the following minerals: zircon, sphene, topaz, staurolite, beryl, cordierite, tourmaline, wollastonite, apatite, fluorite, corundum and calcite.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The Principles of crystallography, including crystal symmetry, space lattices, Bravais lattices, and Bragg's Law.
2. Optical properties of minerals using polarizing microscopes, interference figures, and conoscopic techniques.
3. Uniaxial and biaxial mineral properties, including birefringence, pleochroism, extinction angles, and optic sign determination.
4. Classification of minerals based on their physical, chemical, and optical characteristics, including polymorphism, pseudomorphism, and exsolution.
5. Paragenesis, structural classification, and compositional variations of different mineral groups.
6. Applying crystallographic and mineralogical concepts in geological research, industrial applications, and resource exploration.

Text Books:

1. **Berry, L.G and B. Mason (2019).** Elements of Mineralogy (II eBook Edition), CBS Publishers and Distributors, New Delhi.
2. **Dana, F.S (1955).** A Text Book of Mineralogy, Asia publishing House, Wiley.
3. **Dexter Perkins. (2017).** Mineralogy (III ed.). Pearson India Education Services Pvt. Ltd.
4. **Gribble, C.D. (2005).** Rutley's elements of mineralogy (XXVII ed.). CBS Publication, New Delhi.
5. **Mason, Band L.G. Berry (2004).** Elements of Mineralogy (II Edition), CBS Publishers.
6. **Phillips, P.C (1956).** An Introduction to Crystallography, Longmans Green & Co.
7. **Read, H.H (1974).** Rutley's Elements of Mineralogy, Thomas Murby & Co.
8. **Winchell, A.N (1968).** Elements of Optical Mineralogy, Wiley Eastern Pvt. Ltd.

Reference Books:

1. **Cornelis Klen and Cornelius S. Hurlbut (1985).** Manual of Mineralogy, John Wiley & Sons
2. **Deer, W.A., Howie, R.A and J. Zuessman (1966).** An Introduction of the Rock Forming Minerals, Longmans.
3. **Dyar, M and M.E. Gunter (2007).** Mineralogy and Optical Mineralogy, Mineralogical Society of America.
4. **Gribble, C.D and A.J. Hall (1985).** A Practical Introduction to Optical Mineralogy, Springer.
5. **Kerr, P.F (1959).** Optical Mineralogy, McGraw Hill, New York.
6. **Nesse, W.D (1991).** Introduction to Optical Mineralogy, Oxford University Press, Oxford.

First Year

**CORE COURSE – IV
STRATIGRAPHY**

Semester II

Code:

Credit 4

COURSE OBJECTIVES:

- To know the stratigraphic principles
- To understand the geology of India
- To know the stratigraphic importance of pre Cambrian formations
- To study the importance of age and boundary problems

Unit 1: Essentials of Stratigraphy: Principles of Stratigraphy – Major Stratigraphic Divisions of India – Stratigraphic nomenclature: global level and India – International chronostratigraphic chart: Stratotypes, Global Boundary Stratotype Sections and Points (GSSP) – Concept of lithostratigraphy, chronostratigraphy, biostratigraphy, chemostratigraphy, sequence stratigraphy and magneto-stratigraphy – Methods of stratigraphic correlation – Methods of palaeogeographic reconstruction – Homotaxis and contemporaneity – Facies concept in Stratigraphy: Walther's law – Applications of Stratigraphy.

Unit 2: Precambrians: Stratigraphy of Indian Archaean granites, Greenstone belts, Geological evolution of Archaean nuclei (Dharwar Craton, Bastar, Singhbhum, Aravalli and Bundelkhand) – Economic Importance of the Indian Archaeans – Proterozoic Mobile Belts: Eastern Ghats Mobile Belt, Southern Granulite Terrain, Central Indian Tectonic Zone, Aravalli-Delhi Belt, North Singhbhum Mobile Belt – Proterozoic sedimentary basins: Cuddapah and Vindhyan Super Groups and their equivalence – Economic importance of the Indian Proterozoic formations.

Unit 3: Palaeozoic to Mesozoic: Stratigraphy, fossils and economic importance of: Cambrian of Salt Range – Permo-Carboniferous of Salt Range, Jammu and Kashmir and Spiti – Gondwana Supergroup – Triassic of Spiti – Jurassic of Kutch–Cretaceous of Trichinopoly and Narmada Valley – Bagh beds and Lameta beds – Deccan traps.

Unit 4: Cenozoic, Boundary Problems in Indian Stratigraphy: Stratigraphy, fossils and economic importance of: Assam – Bengal basins – Garhwal-Shimla Himalayas – Siwalik Super Group – Karewas of Kashmir – Indo-Gangetic Alluvium – Overview of Himalayan Geology and Quaternary stratigraphy of India – Age problem pertaining to Saline series and Deccan traps – Boundary problem pertaining to Precambrian/Cambrian, Permian/Triassic, Cretaceous/Tertiary, Paleogene/Neogene and Neogene/Quaternary formations of India.

Unit 5: Geology of Tamil Nadu and Pondicherry: Outline of structure and tectonics – Stratigraphy and economic importance of: Sathyamangalam Group, Layered Mafic and Ultrabasic Complexes – Peninsular Gneissic Complex: Kolar Group, Khondalite and Charnockite Group – Migmatite Complex – Alkaline Complexes (Older) – Mafic dykes – Alkali-Syenite-Carbonatite

Complexes (Younger) – Ultra basics / basics (Younger), Granite (Younger) – Salient features of Palaeozoic, Mesozoic and Cenozoic Era – Tectonic block-wise litho-assemblages of Tamil Nadu.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Principles and methods of stratigraphy and their applications.
2. Stratigraphic framework and economic significance of the Indian Precambrian formations.
3. Stratigraphy, fossils wealth, and economic importance of Indian Palaeozoic and Mesozoic formations.
4. Stratigraphy, fossils wealth, and economic importance of Cenozoic stratigraphy and boundary problems relating to Indian stratigraphy.
5. Geological and stratigraphic setup of Tamil Nadu and Pondicherry.
6. Applying stratigraphic knowledge in palaeogeographic reconstruction, correlation, and resource exploration.

Text Books:

1. **Geological Society of India (2022).** Geology and Mineral Resources of the States of India: Tamil Nadu and Puducherry (Ed. N.P. Nathan and K. Gopalakrishnan), Published by the Geological Society of India, Bengaluru.
2. **Geological Survey of India (2006).** Geology and Mineral Resources of the States of India, Part VI - Tamil Nadu and Pondicherry, GSI Misc. Publ. No. 30, GSI Operation: Tamil Nadu, Kerala & Pondicherry (Government of India), Chennai.
3. **Geological Survey of India (2014).** Geology and Mineral Resources of Tamil Nadu and Puducherry. Miscellaneous Publication No. 30 (Part VI), III Revised Edition, Published by the GSI, Kolkata.
4. **Krishnan, M. S (1982).** Geology of India and Burma, CBS Publishers & Distributors, Delhi.
5. **Ramakrishnan, M and R. Vaidhyadnan (2008).** Geology of India, Vols. I & II, Geological Society of India, Bangalore.
6. **Ravindrakumar (1998).** Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern Ltd., New Delhi.
7. **Wadia, D. N (1998).** Geology of India, Tata McGraw Hill, India.

Reference Books:

1. **Brenner, R. E and T. R. McHargue (1988).** Integrative Stratigraphy: Concepts and Applications, Prentice Hall.
2. **Doyle, P and M. R. Bennett (1996).** Unlocking the Stratigraphic Record, John Wiley and Sons.
3. **Geological Society of India (1990).** Stratigraphic Boundary Problems in India, Memoir 16, ISSN No: 0016-7622, Geological Society of India, Bangalore.
4. **Hedberg, H. D (2008).** International Stratigraphic Guide – A Guide to Stratigraphic Classification, Terminology and Usage, John Wiley & Sons, New York.
5. **Miall, A. D (1997).** The Geology of Stratigraphic Sequence, Springer-Verlag.
6. **Brookfield, M.E (2004).** Principles of Stratigraphy, Wiley Blackwell Publishing.
7. **Naqvi, S. M and J. J. W. Rogers (1987).** Precambrian Geology of India, Oxford University Press.

Course Objectives: To impart knowledge on

1. Morphological characters of fossils such as corals, Graptolites, Trilobites, Brachiopods, Cephalopods, Echinoderms and, their evolutionary trends,
2. Morphological characters of microfossils such as foraminifera and ostracoda and plant fossils
3. Stereographic projection of natural crystals of normal classes, anharmonic ratio, Napier's theorem and equation of the normal, measuring interfacial angle using contact goniometer
4. Identification of minerals by the study of their physical and optical properties and optical mineralogical experiments
5. Identification of minerals based on element / oxide values.

B. Crystallography:

- Stereographic projection of natural crystals of normal classes
- Symmetry projections of 32 classes
- Calculation of crystal elements to test the knowledge of application of tangent relation
- Anharmonic ratio, Napier's theorem and equation of the normal
- Use of contact goniometer in measuring interfacial angles.

C. Mineralogy:

- Identification of minerals from the study of physical and optical properties
- Determination of optical vibration directions, dichroic and pleochroic schemes, sign of elongation, optic sign of uniaxial and biaxial minerals
- Identification of minerals based on element / oxide values.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Morphological characters of fossils such as corals, Graptolites, Trilobites, Brachiopods, Cephalopods, Echinoderms and, their evolutionary trends,
2. Morphological characters of microfossils such as foraminifera and ostracoda and plant fossils
3. Stereographic projection of natural crystals of normal classes, anharmonic ratio, Napier's theorem and equation of the normal, measuring interfacial angle using contact goniometer
4. Identification of minerals by the study of their physical and optical properties
5. Optical mineralogy experiments
6. Identification of minerals based on element / oxide values.

First Year

DISCIPLINE CENTRIC ELECTIVE COURSE -II

Semester II

1. ENGINEERING GEOLOGY

Code:

Credit 4

COURSE OBJECTIVES:

- To know about the geological investigation pertaining to different fields of civil engineering
- To study the different techniques of ore beneficiation To find out instruments used for ore dressing

Unit 1: Engineering Geology: Role of Geologist in Engineering Geology – Areas covered by Engineering Geology – Basic studies required by Engineering Geologist – Elementary concepts of Rock Mechanics and Soil Mechanics – Engineering Properties of Soil and Rock – Methods for measuring engineering properties of soil and rock – Engineering properties of building stones, concretes and aggregates.

UNIT II : Rock Mass Rating (RMR): parameters for estimating Rock Quality Designation (RQD) in the rock mass – Geological Strength Index(GSI) – Rock Index Tests – Outlines on Standard Penetration Test (SPT), Seismic Cone Penetration Test (SCPT) and Core Recovery (CR) – Rock Failure Criteria (Mohr-Coulomb, Griffith and Hoek-Brown Criteria) and Shear strength of rock discontinuities – Rock Mass Classification – Geological reconnaissance, site investigation, characterization and problems related to civil engineering projects – Geotechnical Report (GTR).

Unit III: Geological investigations pertaining to tunnelling / excavation, underground caverns, reservoirs, dams and barrage, highways, ghat roads and bridges .

UNIT IV: Geological investigations pertaining to coastal protection structures – Resource evaluation of construction materials – Environmental considerations related to Civil Engineering projects – Role of Engineering Geology in geohazards and mitigation measures:

UNIT V: Geological investigation on Landslides and geosynthetics, earthquakes and climate change – Important Engineering Geological case studies in India.

COURSE OUTCOMES:

- Got knowledge about the role of geology in the Civil Engineering and type of earth movements
- Understood about the geological investigation in different field of civil engineering constructions
- Gained exposure about the principles of assaying and evaluation of ore bodies their extensions

Text Books:

1. **Arogyaswamy, R.N.P (1986).** Courses in Mining Geology, Oxford & IBH Publishing Co., New Delhi.
2. **Bell, F. G (1983).** Fundamentals of Engineering Geology, Butterworths.
3. **Blyth, F. G H. and M. H. De Freitas (1984).** Geology for Engineers (VII Edition), Elsevier.
4. **Haldar, S.K (2018).** Mineral Exploration Principles and Applications, Elsevier.
5. **Krynine, D. P and W.R. Judd (2018).** Principles of Engineering Geology and Geotechnics, CBS Publ.
6. **McKinstry, H. E (2000).** Mining Geology, Asia Publishing House.
7. **Pandey, V. K and A. Mishra (2017).** Handbook of Engineering Geology, CBS Publishers and Distributors
8. **Parbin Singh (2013).** Engineering Geology, S. K. Kataria& Sons.
9. **Taggart, A.E (1964).** Elements of Ore Dressing, Wiley.
- Venkat Reddy, D (2010).** Engineering Geology, Vikas Publ. House Pvt. Ltd., New Delhi.

Reference Books:

1. **Abzalov, M (2016).** Applied Mining Geology, Springer International Publishing.
2. **Das, B. M and K. Shoban (2017).** Principles Geotechnical Engineering(IX Edition), Cengage Learning.
3. **Donald, P. C (2017).** Geotechnical Engineering: Principles and Practices (II Edition), Pearson Education.
4. **Gokhale, K.V.G.K and D.M. Rao (1981).** Experiments in Engineering Geology, Tata McGraw Hill.
5. **Joseph, E. B (1984).** Physical and Geotechnical Properties of Soils (II Edition), McGraw-Hill Inc.
6. **Maslov, N. N (1987).** Basic Engineering Geology and Soil Mechanics, Mir Publishers.
7. **Murthy, V.N.S (2018).** Soil Mechanics and Foundation Engineering, CBS Publishers and Distributors.
8. **Ries, H and T.L. Watson (2011).** Elements of Engineering Geology. John Wiley & Sons.
9. **Singh, A and P. Rastogi (2006).** Modern Geotechnical Engineering (III Edition), CBS Publ.
10. **Stanton, R.L (1972).** Ore Petrology, McGraw Hill.
11. **Thamus, P.J (1979).** An Introduction to Mining, Methun.

2. QUATERNARY GEOLOGY**COURSE OBJECTIVES:**

- To explore the most recent geological time period, focusing on climatic fluctuations, glaciations, environmental changes.
- To understand stratigraphic records, dating methods, glacial and periglacial processes

Unit 1: Introduction to Quaternary Geology: Overview of the Quaternary period: timing, stratigraphy, and significance – Methods of dating Quaternary deposits: Radiocarbon dating, dendro chronology, luminescence dating – The role of Quaternary geology in understanding long-term Earth processes – Key events of the Quaternary: glaciations, interglacials, and transitions.

Unit 2: Climate Change and Glaciations: Climate during the Quaternary: evidence of climatic shifts – Ice ages: conditions, causes, and consequences – The Pleistocene Glaciations: distribution of ice sheets and their impact – Late Pleistocene climatic fluctuations and Holocene warming – Global climatic cycles: Milankovitch cycles and their influence on Earth's climate.

Unit 3: Glacial and Periglacial Processes: Formation and dynamics of glaciers and ice sheets – Glacial erosion, deposition, and landforms – Periglacial environments and features: frost action, solifluction, and permafrost – Ice-sheet dynamics and climate feedbacks – The Last Glacial Maximum and its global impact.

Unit 4: Quaternary Reconstruction: Methods of Quaternary reconstruction: sediment analysis, pollen analysis, and isotopic studies – Marine and terrestrial records of Quaternary climates – Vegetation and fauna during the Quaternary: evidence from fossils and pollen – The role of human activities in shaping Quaternary environments – Human impact and extinction events during the late Quaternary.

Unit 5: Quaternary Geology and Its Modern Applications: Applications of Quaternary geology in understanding climate change – Quaternary geology in environmental studies and land management – Case studies: impacts of past climate events on present-day ecosystems – Quaternary Geohazards: earthquakes, volcanic eruptions, and sea-level changes – Human history and Quaternary geology: from the Ice Age to modern times.

Course Outcomes: On completion of the course the student would have gained knowledge on
The geological significance and stratigraphic framework of the Quaternary Period.

1. Climatic fluctuations and glacial-interglacial cycles during the Quaternary.
2. Glacial and periglacial processes and interpret related geomorphic features.
3. Application of reconstruction techniques to interpret past environmental and climatic conditions.
4. Applications of Quaternary studies in understanding climate change and geohazards.
5. Interplay between human evolution, migration, and Quaternary environmental changes.

Text Books:

1. **Bowen, D. Q (2008).** Quaternary Geochronology: Methods and Applications. Wiley-Blackwell.
2. **Clark, P. U and R.W. Houghton (2009).** Glacial and Periglacial Geomorphology. Springer.
3. **Ehlers, J and Gibbard, P. L (2007).** Quaternary Glaciations – Extent and Chronology. Elsevier.
4. **Gibbard, P. L and T. van Kolfshoten (2004).** The Quaternary Period in the World. Elsevier.
5. **Hughes, T and R. Gagliardi (2011).** Glacial Systems and Processes. Cambridge University Press.
6. **John Lowe and Mike Walker (2015).** Reconstructing quaternary environments, III Ed.. Routledge, Taylor & Francis Group.
7. **Markgraf, V (2017).** Paleoenvironmental Reconstruction: Methods and Results. Springer.

Reference Books:

1. **Bradley, Raymond, S (1948).** Paleoclimatology: reconstructing climates of the Quaternary, III edition, Academic Press, Elsevier.
2. **Faegri, K and J. Iversen (1989).** Textbook of Pollen Analysis. Wiley.
3. **Last, W. M and J. P. Smol (2001).** Tracking Environmental Change Using Lake Sediments: Volume 2: Physical and Geochemical Methods. Springer.
4. **Ruddiman, W. F (2008).** Earth's Climate: Past and Future. W.H. Freeman.

First Year

**GENERIC ELECTIVE COURSE – II
1. ENVIRONMENTAL GEOLOGY**

Semester II

Code

Credit 3

COURSE OBJECTIVES:

- To understand the Sources and inducing factors of disasters.
- To understand the consequences of natural disasters
- To study the different management plans for natural hazards and disasters.

Unit 1: Basic concepts of Environmental Geology – Outline of Earth in space and time – Energy sources of disasters: internal and external sources – Earthquakes: hazards of earthquakes, strategies for their reduction and the role of geology – Volcanic activity: its hazards of volcanic activity, strategies for their reduction and the role of geology.

Unit 2: River flooding: factors governing its severity, its hazards, strategies for their reduction and the role of geology – Mass movement: factors influencing slope stability, types and hazards of mass movement, strategies for their reduction and the role of geology – Soil erosion: factors influencing it, its hazards, strategies for their reduction and role of geology – Environmental impacts of: mining activities, hydropower projects, disposal of nuclear wastes.

Unit 3: Coastal hazards (coastal erosion, coastal flooding, sea water intrusion): strategies for their reduction and the role of geology – Impacts of human activities on marginal marine environments: estuaries, mangroves and corals reef – Global climate change: causes and effects – Surface and groundwater pollution – Desertification: causes and effects – Impacts of urbanization – Coastal Regulation Zone, Submarine groundwater discharge.

Course Outcomes:

On completion of the course the student would have gained knowledge on

1. Concepts of Environmental Geology, natural disasters such as earthquake and volcanic eruption and the role of Geology in mitigating their impacts
2. Natural disasters such as river flooding, mass movements, soil erosion, and the role of Geology in mitigating their impacts and about environmental impacts of human activities.
3. Impact of human activities on coastal and marine environments and assess strategies for environmental conservation.
4. Examine marine geological processes, including ocean circulation, water chemistry, seafloor tectonics, and hydrothermal systems

Text Books:

1. **Duff, D (1993).** Holmes' Principles of Physical Geology (IV Edition), Chapman & Hall.
2. **Keller, E.A (2012).** Introduction to Environmental Geology (V Edition), Pearson Prentice Hall.
3. **Kennett, J.P (1982).** Marine Geology. Prentice Hall, London.
4. **Kind, A.H (1979).** Introduction to Marine Geology and Geomorphology, Edward Arnold.
5. **Montgomery, C.W (2019).** Environmental Geology (IX Edition), McGraw-Hill Pub.
6. **Trujillo, A.P and H.V. Thurman (2011).** Essentials of Oceanography, X Edition Prentice Hall.
7. **Valdiya, K.S (1987).** Environmental Geology – Indian Context, Tata McGraw Hill Publications.

Reference Books:

1. **Bhatt, J.J (1994).** Oceanography: Exploring the Planet Ocean. D. Van. Nostrand Company, New York.
2. **Ross, D.A (1977).** An Introduction to Oceanography, Prentice Hall.
3. **Gross, M.G (1977).** Oceanography: A View of the Earth, Prentice Hall.
4. **Jin Erickson (2002).** Environmental Geology, Facts on File, Inc.
5. **Kerth, S (1996).** Ocean Science, John Wiley & Sons Inc.
6. **Philip, K (1950).** Marine Geology, Wiley.
7. **LaMoreaux, J.W (2019).** Environmental Geology, Springer Science+Business Media.
8. **McConnell, R.L and D.C Abel (2015).** Environmental Geology Today, Jones and Bartlett Learning.
9. **Reichard, J.S (2011).** Environmental Geology, McGraw Hill.
10. **Seibold, E (1982).** The Sea Floor. Springer-Verlag.
11. **Shepard, F. P (1994).** Submarine Geology, Harper and Row Publ.
12. **Turekian, K.K (1968).** Oceans, Prentice Hall Publ.

COURSE OBJECTIVES:

- To study the soil and rock mechanics, site investigations, geotechnical testing, construction materials, and geological aspects of civil engineering projects.
- To study the significance of geotechnical investigations in the design and execution of infrastructure projects and addresses the geological causes of structural failures and their mitigation.

Unit 1: Introduction to Geotechnics – Formation of the Quaternary soil layers – Soils of Geological past – Review on Indian bedrocks – Soil properties: soil components and classification – Structure of soils – Mechanics of materials: stress and strain under conditions of tension, compression and shear – Elastic, plastic and time-dependent material – Multi-axis stress state – Conditions of failure – Soil Mechanics: soil stress and deformation – Tension in the soil-water system: total pressure, pore pressure and effective pressure – Soil compression – Soil shear and failure – Soil composition – The consolidation process – Soil's carrying capacity – Soil pressure – Soil slope stability – Rock mechanics: Rock strength and deformation properties – Rock mechanics calculations – Rock classification.

Unit 2: Geological reconnaissance, site investigation, characterization and problems related to Civil Engineering projects – Geotechnical Report (GTR) – Laboratory and field geotechnical tests: Applications of Geophysical (electrical) methods in Geotechnical investigations or Civil Engineering problems – Ground investigations – Penetration tests: Standard Penetration Test (SPT) and Seismic Cone Penetration Test (SCPT) – Drilling, Sampling (Bore Holes and Trial Bits) - Core Recovery (CR) – Logging, Bore-Log Report and Data Interpretation – Rock Quality Designation (RQD) – Bienawiski's Rock Mass Rating (RMR).

Unit 3: Construction materials: Geologic considerations and physical characteristics of building stones, concrete aggregates and rail road ballasts – Outline on Geosynthetics – Types of foundations and safe bearing capacity – Environmental considerations related to Civil Engineering Projects – Geological investigations pertaining to the development of roads/highways, airfields, bridges and buildings.

Unit 4: Dams and Reservoirs: Types of dams, geological investigations for dams and reservoirs – Dam foundation, construction, problems and remedial measures – Spill way problems and reservoir problems – Tunnels/Excavation sites: Geological investigations preceding tunneling or excavation – Problems relating to tunneling or excavation in hard and soft grounds – Coastal Structures: Geotechnical investigations pertaining to the construction of harbour and docks.

Unit 5: Natural hazards / geological causes for the failures of engineering structures and mitigation strategies – Geological and geotechnical investigations for the areas prone to mass movements with special emphasis on landslides – Causes of hill-slope Instability – Slope stability – Geological investigations pertaining to coastal protection, structures for control or preventive measures of coastal erosion and other impacts – A note on earthquake-resistant structures – Impacts of climate change on Engineering Geology and mitigation measures – Important Engineering Geological case studies.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The fundamental principles of Geotechnics including soil and rock mechanics.
2. Site investigations for engineering projects and, interpretation of geotechnical data.
3. The evaluation of geological characteristics of construction materials and design foundations.
4. Geotechnical considerations in construction of dams, tunnels, coastal, other civil structures.
5. Identifying sites areas prone for geological hazards and their mitigation measures.
Applying geotechnical knowledge in the planning and execution of slope stability analysis, earthworks, and ground improvement techniques

Text Books:

1. **Das, B. M and K. Shoban (2017).** Principles Geotechnical Engineering (XI Edition), Cengage Learning.
2. **Gokhale, K.V.G.K and D. M. Rao (1981).** Experiments in Engineering Geology, Tata McGraw-Hill.
3. **Pandey, V. K and A. Mishra (2017).** Handbook of Engineering Geology, CBS Publishers and Distributors.
4. **Parbin Singh (2013).** Engineering Geology, S. K. Kataria& Sons
5. **Sivakugan N and Das, B. M (2014).** Geotechnical Engineering: A Practical Problem Solving Approach, Cengage Publishers.

Reference Books:

1. **Bell, F. G (1983).** Fundamentals of Engineering Geology, Butterworths.
2. **Blyth, F. G. H and M. H. De Freitas (1984).** Geology for Engineers (VII Edition), Elsevier.
3. **Coduto, D. P., Yeung, M. R and W. A. Kitch (2010).** Geotechnical Engineering: Principles and Practices, Prentice Hall.
4. **Harrison, J. P and J. A. Hudson (2001).** Engineering Rock Mechanics: Part 2: Illustrative Worked Examples, Pergamon Publishers.
5. **Hudson, J. A and J. P. Harrison (2000).** Engineering Rock Mechanics: An Introduction to the Principles, Pergamon Publishers.
6. **Krynine, D. P and W. R. Judd (2018).** Principles of Engineering Geology and Geotechnics, CBS Publishers and Distributors.
7. **Maslov, N. N (1987).** Basic Engineering Geology and Soil Mechanics, Mir Publishers.
8. **Murthy, V. N. S (2018).** Soil Mechanics and Foundation Engineering, CBS Publishers and Distributors.
9. **Richard Bassett (2011).** A Guide to Field Instrumentation in Geotechnics: Principles, Installation and Reading, CRC Press.

10. **Ries, H. and T. L. Watson (2011).** Elements of Engineering Geology. John Wiley & Sons.
11. **Robert W. Day (2012).** Geotechnical Engineers Portable Handbook (II Edition), McGraw-Hill Education.
12. **Ruwan Abey Rajapakse (2015).** Geotechnical Engineering Calculations and Rules of Thumb (II Edition), Butterworth-Heinemann.
13. **Steve Hencher (2012).** Practical Engineering Geology (Applied Geotechnics), CRC Press.
14. **Venkat Reddy, D (2010).** Engineering Geology, VikasPubl. House Pvt. Ltd.
15. **Vutukuri, V. S., Lama, R. D and S. S. Saluja (1974).** Handbook of Mechanical Properties of Rocks (Vol. 1, 2, 3 & 4), Trans./Tech. S. A.

First Year

GENERIC ELECTIVE COURSE – II
3. ISOTOPE GEOLOGY

Semester II

Code

Credit 3

COURSE OBJECTIVES:

- To understand the principles and applications of isotopes in geological processes.
- To understand isotopic behavior in Earth systems and their significance in dating rocks, tracing geological processes, and exploring natural resources

Unit 1: Introduction to isotopes and nuclear systematic: Discovery of radioactivity, stable and radiogenic isotopes – Introduction to isotope geology – Nuclear structure, atomic weights, nuclear stability and abundance – Theory and mechanism of decay, particles emitted, positron, negatron and alpha decay – Equations of radioactive decay and radiogenic growth.

Unit 2: Fundamentals of stable isotope geochemistry – Oxygen and hydrogen isotopes in the hydrosphere, atmosphere and lithosphere – Stable isotopes of carbon, nitrogen and sulphur – Fractionation of stable isotopes – Carbon isotopes in the Earth's reservoirs – Sulphur isotopes and their applications in ore geology.

Unit 3: Effect of mineral/crystal structures, growth and retention of daughter isotopes in earth systems – Abundances of unstable nuclides in earth, core, mantle, crust, oceans and different rock types; their decay schemes – Radioactive elements as major elements, minor elements and trace elements and their geochemical behaviour.

Unit 4: Geochronology – Isotope Geology of Sr, Nd, Pb and Ar, and their applications – Applications of stable isotopes in geothermometry and geobarometry – Isotopes in mineral exploration, petroleum exploration, paleo-climate evaluation, health and environmental aspects – Cosmogenic nuclides and their applications.

Unit 5: Introduction to analytical techniques and mass spectrometry – Mass spectrometer: instrumentation, chemical separation, isotope dilution and ratio analysis – Methods of dating: Isochron method, model/mineral ages, fission track, ^{40}Ar - ^{39}Ar , U and Th disequilibrium, choncordia method, ^{14}C , Be and Al – Interpretation and geological significance of ages – Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The concepts of nuclear structure, radioactivity, and types of radioactive decay.
2. The role of stable isotopes (O, H, C, N, S) in Earth systems and geological processes.
3. The influence of mineral structures and geochemical behavior on isotope distribution and retention.
4. Applying isotopic systems for dating geological events and reconstructing temperature-pressure conditions.

5. The analytical methods such as isotope dilution and mass spectrometry used in isotope geology.
6. Interpreting age data and isotope signatures to infer geological history and processes across different rock types.

Text Books:

1. **Faure, G (1986).** Principles of Isotope Geology (II Edition), John Wiley & Sons.
2. **Faure, G and T. M. Mensing (2005).** Isotopes: Principles and Applications (III Edition), John Wiley & Sons.
3. **Sharp Zachary (2006).** Principles of Stable Isotope Geochemistry, Prentice Hall.

Reference Books:

1. **Dickin, A. P (1995).** Radiogenic Isotope Geology, Cambridge University Press.
2. **Faure, G and J.L. Powell (1972).** Strontium Isotope Geology. Springer Verlag.
3. **Hoefs, J (1987).** Stable Isotope Geochemistry (III Edition). Springer-Verlag.
4. **Rollinson, H. R (1993).** Using Geochemical Data: Evaluation, Presentation, Interpretation, Longman, Harlow.
5. **William, W.M (2014).** Isotope Geochemistry, Wiley.

First Year

**SKILL ENHANCEMENT COURSE-I
FIELD GEOLOGY**

Semester II

Code:

Credit 2

COURSE OBJECTIVES:

To get knowledge on importance of Field Geology and usage of various gadgets in the field.

UNIT-I:

Need of field geology and role of field geologist –field equipments–places of importance for the field geologist–where to look for outcrops, fossils & other geological features. Pitting & trenching the ore bodies, Drilling-types and uses, estimation of reserves.

UNIT-II:

Topographic features, methods of representing topography on maps– Clinometer compass & Brunton Compass, their uses-detailed study of contouring–dip–true dip and apparent dip, the relationship–strike. Influence of dip and ground slope on outcrops.

UNIT-III:

True thickness & Vertical thickness of beds, their measurement in the field, relationships between true thickness and vertical thickness their calculation from field data. Conditions that bring about repetition of outcrops.

UNIT-IV:

Sampling – definition of a sample – sample requirement as to the size, purity contamination, packing. Important methods of sampling – Car samples, muck samples, channel samples, grit samples, chip samples, drill hole sampling or core sampling. Conning and quartering.

UNIT-V:

Topographic map – details, printed on the map, cardinal points (directions) conventional signs, scale of map, map references (indexing), orienting the map, locating the position of outcrop on a map, plotting attitude of beds, symbols used for rock types & various structural features – a note on line of preparation of geological map and report.

UNIT VI - CURRENT CONTOURS: (For continuous internal assessment only):

New trends in field survey techniques and instruments – Total Station-GPR.

COURSE OUTCOMES:

Get the knowledge on Field Geological equipments and its utilities.

REFERENCES:

1. G.W.Chiplonker, DastaneBros: Geological Maps,Pune.
2. J.A.G.Thomas:Interpretation to Geological maps, Murby Publishers.
3. W.B.Upton:Landformsand topographic maps,, John Wiley Publishers
4. A.Ye.Mikhaila: Structural geology and geological mapping ,Mir Publishers.
5. N.W.Gokhale:Manual of geological maps,CBS Publishers and Distributors.
6. M.P.Billings, Prentice: Structural Geology,– Hall India Ltd.

First Year

NON-MAJOR ELECTIVE-I

Semester II

INTRODUCTION TO MINERALS, ROCKS AND FOSSILS

Code:

Credit 3

COURSE OBJECTIVES:

- To create awareness and importance of Mineral, Crystals, Gemstone, Ore Gangue minerals.
- To study the Commercial significance of igneous, metamorphic and sedimentary rocks.
- To Study about fossils and its application.

UNIT – I: Definitions of Mineral and Crystals, Ore and Gangue. Brief study of Physical Properties of Minerals; Nature, Streak, Cleavage, Hardness, Luster and fracture. Description of physical properties and chemical composition of the following mineral groups-Quartz group - Feldspars group-Pyroxenes group - Amphiboles group.

UNIT – II: Study of Physical properties, Chemical composition and origin of the mineral used in the following industries: Cement industry, Glass and Ceramic industry, Paint industry, Paper industry, Fertilizer industry, Atomic industry, physical chemical properties of gemstone. Classification of gemstone, occurrence of gemstone in Tamilnadu – Ruby, Sapphire, Emerald, Moonstone and Iolite. Rocks:

UNIT – III: Brief study of common characters of igneous, metamorphic and sedimentary rocks. Structures and texture of igneous, metamorphic and sedimentary rocks. Engineering properties of building stone. Important ornamental and architecture properties of rocks.

UNIT – IV: Descriptive study of structure, texture, mineralogy and origin of the following igneous rocks: Granite, Syenite, Gabbro, Dunite, Basalt, Pegmatite, Anorthosite and Dolerite. Description of texture, mineralogy and origin of the following sedimentary rocks: sandstone, conglomerate, Breccia, Shell-Limestone and Shale. Brief study of the following metamorphic rocks: Slate, Schist, Gneiss, Marble and Charnockites. Fossils:

UNIT – V: Introduction of Palaeontology. Definition of fossils – mode of preservation of fossils. Types of fossils -Uses of fossils. Morphological identification and description of the following fossils: Corals: Calceola, zaphrentis; Brachiopoda: Spriifer, Productus, Terebratula; Pelecypoda: Arca, Cardium. Meretrix, Cardita, 45 Pecten; Gastropoda: Natica, Turbo, Trochus, Turritella, Physa; Cephalopoda: Nautilus, Goniatites, Ceratites. Plant fossils: Glossopteris , Gangmopteris , Calamites , Lepidodendron, Sigillaria and Ptilophyllum.

COURSE OUTCOMES:

Understand distribution, geological setting and genesis of minerals, rocks and fossils. Factors controlling the formation of these deposits, reserves & preservation of fossils and the linkages with many other geologic processes.

REFERENCES:

1. Dana, F.S. (1955): A text book of mineralogy – Asia publishing House, Wiley.
2. Tyrrel, G.W. (1978) :The principles of petrology – Chapman and Hall Ltd., London.
3. Mahapatra, G.B(2008): A text book of Geology, CBS, Delhi
4. Lindgren W.(1993):Mineral Deposits, MCGraw Hill.
5. Henry Woods (1967) : Invertebrate Palaeontology – Cambridge University Press, London

SECOND YEAR

CORE COURSE – 5
IGNEOUS AND METAMORPHIC PETROLOGY
(Theory)

Semester III

Code

CREDIT:4

Course Objectives:

To impart knowledge on

1. Forms, structures, textures, and genesis of igneous rocks and their evolution through magmatic processes.
2. Thermodynamic principles and crystallization behaviour of magmas in various systems.
3. Relationship between igneous rocks and tectonic settings and study important Indian rock suites.
4. Metamorphic processes, structures, mineralogical changes, and their tectonic significance.
5. Thermodynamic principles to study metamorphic equilibria, geothermobarometry, and common metamorphic rock types.

Unit 1: Forms of igneous rocks – Structures and textures of igneous rocks – Classification of igneous rocks – Outline on the generation of magma – Types of magma and their chemical composition – Physical properties of magma – Viscosity, temperature and pressure relationships in magmas – Magma ascent and magma diversity: magmatic differentiation, assimilation, magma – mixing, –mingling and –immiscibility – Types of mantle melting (batch, fractional and dynamic).

Unit 2: Elementary thermodynamics: Laws of thermodynamics, Gibb's Phase rule and Lever rule and their application to igneous petrogenesis – Bowen's reaction series – Crystallization of unary magma: SiO_2 system – Crystallization of binary magma: simple eutectic (Diopside-Anorthite), solid solution (Albite-Anorthite, Forsterite-Fayalite) and incongruent melting (Forsterite-Silica) – Crystallization of ternary magma: Diopside-Forsterite-Silica melt systems, Diopside-Albite-Anorthite melt systems and Anorthite-Forsterite-Silica melt systems – Role of volatiles in crystallization – Trace elements and their application in fractional crystallization – REE distribution in rocks and their application to igneous systems.

Unit 3: Igneous rocks and plate tectonic settings: igneous rocks at divergent boundary (mid-oceanic ridges, rift valleys), igneous rocks at convergent boundary (subduction zones), igneous rocks in intraplate (above hotspots, continental flood basalt and large igneous provinces) – Outline on the petrogenetic aspects of important rock suites of India: Deccan basalts, dolerites, ultramafics, komatiites, layered intrusive complexes, anorthosites, alkaline rocks, carbonatites, syenites, granites (granitoids), kimberlites, lamprophyres, and ophiolites.

Unit 4: Metamorphism: controls, limits and agents – Types of metamorphism – Outline on metamorphism of partial melting, metasomatism, anatexis and palingensis – Metamorphic structures and textures – Mineralogical changes due to metamorphism: zones, grades and facies – Chemographic diagrams: ACF, AKF, AFM – Plate tectonic significance of metamorphism: Pressure Temperature Time (P-T-t) paths and metamorphic facies series.

Unit 5: Equilibrium concepts in thermodynamics: enthalpy, entropy, Gibb's free energy, chemical potential and equilibrium – Gibb's phase rule and Claussius-Clapeyron equation –

Geothermobarometer – Metamorphism of pelitic, mafic and impure carbonate rocks – Study on common metamorphic rocks: slate, phyllite, schist, gneiss, amphibolite, eclogite, granulite, khondalite, migmatite, marble, quartzite.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The physical, chemical properties of magmas, classification, structures, and textures of igneous rocks.
2. Application of thermodynamic principles in the crystallization processes of magmas and interpret phase diagrams.
3. Relation between the distribution of igneous rocks to plate tectonic settings and study the petrogenesis of Indian rock suites.
4. Metamorphic processes, types, structures, mineralogical changes, and the significance of metamorphic facies.
5. Application of thermodynamic concepts to metamorphic equilibria and study geothermobarometric methods.
6. The identification, classification and description of common igneous and metamorphic rocks based on mineralogy, texture, and origin.

Text Books:

1. **Best, M.G (1993).** Igneous and Metamorphic Petrology, CBS Publishers and Distributors.
2. **Ehlers E.G (1999).** Petrology: Igneous Sedimentary & Metamorphic, CBS Publishers and Distributors.
3. **Hatch R. H and A.K. Wells (2003).** Petrology of the Igneous Rocks, CBS Publishers and Distributors.
4. **Halder S. K and Tisljar Josip (2014).** Introduction to Mineralogy and Petrology, Elsevier.
5. **Turner, F.J and J. Verhoogen (1960).** Igneous and Metamorphic Petrology, McGraw Hill.
6. **Tyrrell, G.W (1963).** Principles of Petrology, Asia Publishing House.
7. **Winter J.D (2014).** Igneous and Metamorphic Petrology, Prentice Hall.

Reference Books:

1. **Antony Hall (1992).** Igneous Petrology, ELBS.
2. **Frost, B. R and D.C Frost (2014).** Essentials of Igneous and Metamorphic Petrology, Cambridge University Press.
3. **Gautham Sen (2014).** Petrology, Springer Publications.
4. **McKenzie, W.S., Donaldson, C.H and C. Guilford (1982).** Atlas of Igneous Rocks and their Textures, Longman.
5. **McBirney, A.R (1994).** Igneous Petrology, CBS Publishers and Distributors.
6. **Morse, S.A (1980).** Basalts and Phase Diagrams, Springer Verlag.
7. **Phillipots R. Anthony and Cornelis Klein (2017).** Earth Materials: Introduction to Mineralogy and Petrology, Cambridge University Press.
8. **Raymond, L. A (2001).** Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks, McGraw Hill.
9. **Winkler, H.G.F (1967).** Petrogenesis of Metamorphic Rocks, Springer and Verlag.

SEOCND YEAR

CORE COURSE – 6
SEDIMENTARY PETROLOGY
(Theory)

SEMESTER: III

Code

Credit: 4

Course Objectives: To impart knowledge on

1. The processes of sedimentation, lithification, diagenesis, and classification of sedimentary rocks.
2. Sedimentary environments and facies distribution in different depositional settings.
3. The relationships between plate tectonics and sedimentation, along with the classification of sedimentary basins.
4. Sedimentary provenance, basin evolution, sequence stratigraphy, and depositional systems.

Unit 1: Sedimentation Process: Sedimentation, lithification and diagenesis – Textures and structures of sedimentary rocks – Classification and composition of sedimentary rocks – Study of residual deposits: terra rossa, clay with flint, laterite, bauxite, residual clays – Study of clastic rocks: rudaceous (Conglomerate and Breccia), arenaceous (Sandstone and its classification), volcano-clastic deposits, siltstones, mudstones – Study of non-clastic rocks (limestones and dolomites, siliceous deposits, ferruginous deposits, carbonaceous deposits, phosphatic deposits, evaporites).

Unit 2: Techniques in Sedimentology – Collection and analysis of field data – Quantitative grain size analysis of sediments – Interpretation of data for understanding the geological significance – Microscopical techniques – Cathodoluminescence – X-ray diffraction – Scanning electron microscope – Application of trace elements, rare earth elements and stable isotope geochemistry in Sedimentology – Heavy minerals and their significance.

Unit 3: Sedimentary facies and products: continental, continental margin, oceanic facies – Non marine environments: desert, fluvial, lake and glacial-environments, climatic significance of red beds – Transitional environments: coast, estuary, deltas, shore fans, barrier complexes and peritidal complexes – Marine environments – Continental shelf, slope and rise – Sedimentary basins of India and their importance.

Unit 4: Concept of plate tectonics and sedimentation – Classification and description of basins: down-warp basins, rift basins, interior basins, foreland basins, subduction basins, pull apart basins, delta type basins, composite basins – Basin formation: basins in compressional zones, strike slip zones, transform fault zones – Geosynclines: stratigraphy and sedimentation.

Unit 5: Provenance and Basin analysis: Basin and its lithic fill, palaeoslope, palaeocurrent, palaeo-fluvial channels and depositional environment – Diagnostic and maturation, sediment chemistry, basin evolution and tectonics – Sequence stratigraphy: para-sequence sets and stacking patterns: progradational stacking, aggradational stacking, retrogradational stacking – Depositional sequence: Low-stand System Tract (LST), Transgressive System Tract (TST), High-stand system Tract (HST) – Sequence boundary, transgressive surface, maximum flooding surface.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The processes involved in sedimentation, lithification, diagenesis, and classify sedimentary rocks.
2. Sedimentological techniques and analytical tools for the study of sediments and sedimentary rocks.
3. Sedimentary facies and depositional environments.
4. Sedimentary basins in relation to plate tectonics and basin-forming processes.
5. Provenance studies and interpret basin evolution based on sediment chemistry and structural controls.
6. Sequence stratigraphy and its application in sedimentary basin analysis.

Text Books:

1. Gary Nichols (2019). Sedimentology and Stratigraphy, Wiley India.
2. Petijohn, F.J (2002). Sedimentary Rocks (III Edition), CBS Publishers & Distributors.
3. Prothero, D. R and Schwab, F (2003). Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy, W. H. Freeman.
4. Reading, H.G. (1996). Sedimentary Environments: Processes, Facies and Stratigraphy. Blackwell Publishing.
5. Sengupta (2018). Introduction to Sedimentology, CBS Publishers
6. Tucker, M.E (2001). Sedimentary Petrology, Blackwell Science.
7. Williams, H., Turner, F.J and C.M Billbert (1954). Petrography, Freeman

Reference Books:

1. Bayly, B (1968). Introduction to Petrology, Prentice Hall.
2. Bhattacharyya, C. Chakraborty (2000). Analysis of Sedimentary Successions, Oxford and IBH Publishing Co.
3. Blum, M.D., Marriot, S.B and F. Leclair (2005). Fluvial Sedimentology, Blackwell Publishing, London
4. Hsu, K.J (2004). Physics of Sedimentology (II Edition), Springer Verlag, London
5. Krumbein, W.C. and L.L. Sloss (1951). Stratigraphy and Sedimentation, Freeman.
6. Michael McLane (1995). Sedimentology, Oxford University Press, London
- Sam Boggs (2000). Principles of Sedimentology and Stratigraphy, Pearson USA

Course Objectives: To impart knowledge on

1. Identification of igneous and metamorphic rocks by the study of their physical and optical properties and interpretation of petrogenetic processes using variation diagrams.
2. Identification of sedimentary rocks by the study of their physical and rocks and analyzing sediment grain size for deciphering depositional environment interpretations.
3. Identification of metamorphic rocks and interpreting metamorphic assemblages using graphical methods.
4. To understand the techniques involved in Satellite data interpretation.

A. Petrology

i) Igneous Petrology

- Identification of igneous rocks using their megascopic and microscopic characters
- Problems relating to C.I.P.W. Norm
- Harker's diagram and Niggli variation diagram
- Problems relating to Niggli values and Niggli basis
- Variation diagrams

ii) Sedimentary Petrology

- Identification of sedimentary rocks from their megascopic and optical characteristics
- Grain size analysis of sediments

iii) Metamorphic Petrology

- Identification of metamorphic rocks from their megascopic and optical characteristics
- ACF, AKF and AFM diagrams for representation of metamorphic rock assemblages

1. Remote Sensing

1.1 Aerial Remote Sensing

- Elementary exercises relating to photogrammetry: determination of scale, flying height, areal extent, flight planning measures
- Annotation of aerial photographs
- Stereovision test
- Orientation of aerial photographs for interpretation using mirror stereoscope
- Interpretation of aerial photographs for identification of rock types, geological structures (Including lineaments), landforms and land use / land cover

1.2 Satellite Remote Sensing

- Annotation of satellite image
- Visual interpretation of satellite image for identification of rock types, geological structures (Including lineaments), landforms and land use / land cover
- Digital image processing for land use / land cover classification

1.3 GIS

- Introduction to ArcGIS and Arc Catalog
- Attribute data and basic queries
- Georeferencing and Digitization
- Data entry and editing
- Data conversion and analysis
- Surface analysis, density analysis
- Watershed analysis
- Spatial data visualization and Map lay out

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Aerial photogrammetry, stereo-viewing, orientation of aerial photographs.
2. Interpretation of aerial photographs for various geological applications.
3. Visual and digital interpretation of satellite imagery for landform and land use classification.
4. Operate ArcGIS tools for georeferencing, digitization, and attribute data management.
5. Working knowledge on GIS software (ArcGIS), attribute data handling, and spatial analysis.
6. Map layout generation for real-world applications.

SEOCND YEAR DISCIPLINE CENTRIC ELECTIVE COURSE –III SEMESTER III
1. MINING GEOLOGY

Code

CREDIT: 4

COURSE OBJECTIVES:

- To study the different sampling techniques
- To find out the factors controlling the choice of various mining methods

UNIT-I:

Mining terms and their descriptions. Sampling - Principles – Types of sampling – Collection&preparationofsamples.Assayingandevaluationofore-bodiesand their extensions-ore reserve estimation.

UNIT-II:

Drilling: Types of drills – methods of drilling – geological logging.Explosives-Blasting – Rock excavations. Methods of stoping. Ventilation. Haulage. Shafts and shaft sinking.

UNIT-III:

Alluvial mining: panning, sluicing, hydraulicking, drift mining anddredging. Opencast mining: Mine machinery-power shovel, bucket wheel excavator, conveyor and spreader. Types of mining- Glory hole, Kaolin mining, Granite mining, sand mining, stripping.

UNIT-IV:

Subsurface mining (or) Under ground mining;-Stoping : Open stopes – supported stopes,shrinkagestopes.Caving;-Topslicing-sublevelcaving–blockcaving. Ground water control – Mine ventilation

UNIT-V:

Coal Mining: Prospecting and planning – underground mining –Room and pillar method–longwall(advancing&retreating)method–Pillarrobbing-Hydraulicking – Power source roofing – transportation; strip mining of coal – Augering-cleaning – Grading – Shipping – Future trends in India. Mining and environment,Mitigationofmininghazards.Factorscontrollingthechoiceof various mining methods.

UNIT -VI: CURRENT CONTOURS (For Continuous Internal Assessment only):

Contemporary methods for excavation of ores.

COURSE OUTCOMES:

- Able to Demonstrate familiarity with a wide range of mineral deposits
- Gained knowledge about different mining methods.
- Understood about assaying and evaluation of ore bodies their extensions
- Able to discuss about factors controlling the choice of various mining methods.

REFERENCES:

1. Arogyaswamy, R.N.P. 1973 Courses in Mining Geology, Oxford & IBH, New Delhi. Higham, S. 1951 An introduction to Metalliferous mining, Lord
2. okhale, K.V.G.K and Rao, T.C. 1978 Ore deposits of India distribution and processing, Thomson.
3. McKinsty, H.E. 1960 Mining Geology, New York.
4. Gauding, A.M. 1939 Principles of Mineral Dressing, McGraw Hill.
5. Thamus, P.J. 1979 An introduction to mining, Methun.
6. Taggart, A.E. Elements of ore dressing.
7. Stanton, R.L. 1972 Ore Petrology, McGraw Hill.
8. Aurele Parriaux, 2009, Geology Basics for Engineers, CRC Press
9. Howard L. Hartman, 2002, Introductory Mining Engineering, John Wiley & sons
10. James Park, 2013, A Textbook of Mining Geology for the use of Mining Students and Miners, General books
11. Marot Abzalov, 2016, Applied Mining Geology, Springer
12. Samuel John Truscott, 2018, A Textbook of Ore Dressing, FB & C Limited
13. Robert Hallowell Richards, 2014, A Textbook of Ore Dressing—Primary source Edition, Biblio life

2. MEDICAL GEOLOGY

Code

CREDIT: 4

Course Objectives: To impart knowledge on

1. The fundamental relationship between public health and geological processes, including natural and anthropogenic sources of elements and their biological roles.
2. Exposure pathways of toxic elements like arsenic, fluoride, and radon, and understand related health effects and standards.
3. Geochemical causes of diseases such as tropical endomyocardial fibrosis and urolithiasis, and their relation to water chemistry.
4. Environmental cycles of iodine and nitrogen, and their effects on human health, including deficiencies and toxicities.
5. Health impacts of selenium and iodine deficiency, natural aerosolic mineral dusts, and micronutrient deficiencies in soils.

Unit 1: Medical Geology: perspectives and prospects – Public health and Geological processes: An overview of a fundamental relationship – Natural distribution and abundance of elements, anthropogenic sources – Uptake of elements on chemical and biological perspective and its functions – Geological impacts on nutrition.

Unit 2: Pathways and Exposure – Volcanic emissions and health – Radon in air and water – Arsenic in groundwater and the Environment – WHO and BIS standards for drinking water – Fluoride in natural waters, soils, sediments, plants – Fluorides and health: Bioavailability of fluoride, dental fluorosis, skeletal fluorosis, dental fluorosis in India, source, nature, cause and extent.

Unit 3: Water hardness and health effects – Geochemical basis for tropical endomyocardial fibrosis (EMF) – Effect of water hardness on urinary stone formation (urolithiasis) – Types of stones: Calcium oxalate, calcium phosphate, uric acid, magnesium ammonium phosphate stones, cysteine.

Unit 4: Iodine and health: The iodine cycle in the environment, iodine in drinking water, iodine in food, Iodine Deficiency Disorders (IDD), endemic cretinism, goitrogens – The nitrogen cycle, nitrate as fertilizers and environment, nitrogen loading in rice fields, nitrates from human and animal wastes, nitrates and health, nitrates and Methemoglobinemia, nitrates and cancer – Bioavailability of elements in soil.

Unit 5: Selenium deficiency and toxicity in the environment – Soils and iodine deficiency – Natural aerosolic mineral dusts and human health – Animals and Medical Geology – The impact of micronutrient deficiencies in agricultural soils and crops on the nutritional health of humans.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The fundamental relationship between public health and geological processes, including natural and anthropogenic sources of elements and their biological roles.
2. Exposure pathways of toxic elements like arsenic, fluoride, and radon, and understand related health effects and standards.
3. Geochemical causes of diseases such as tropical endomyocardial fibrosis and urolithiasis, and their relation to water chemistry.
4. Environmental cycles of iodine and nitrogen, and their effects on human health, including deficiencies and toxicities.
5. Health impacts of selenium and iodine deficiency, natural aerosolic mineral dusts, and micronutrient deficiencies in soils
6. The implications of micronutrient deficiencies and mineral dusts on animal and human health.

Text Books:

1. **Dissanayake, C.B and R.Chandrajith (2009).** Introduction to Medical Geology, Springer.
2. **Antony R. Berger (2003).** Geology and Health: Closing gap, Oxford Univ. Press.
3. **Valdiya, K.S (2004).** Geology, Environment and Society, University Press.
4. **Dissanayake, C.B and R. Chandrajith (2009).** Introduction to Medical Geology, Springer, London.

Reference Books:

1. **Komatica, M.M (2004).** Medical Geology, Vol. 2, Effects of Geological Environment on Human Health, Elsevier.
2. **Volfson (2010).** Medical Geology: Current Status and Perspectives, Russian Geological Society Pub.
3. **Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammam (2009).** Heavy Metals in the Environment, CRS Press, Taylor & Francis Group.

1. REMOTE SENSING AND GIS**Code****Credit 3****Course Objectives:** To impart knowledge on

1. Basic principles of electromagnetic remote sensing, spectral reflectance of Earth's atmosphere and Earth's surface features, and data acquisition receiving and recording process.
2. Aerial Remote Sensing which includes types of aerial photographs, photographic scale and causes for its variations, flight planning missions, stereoscopes and stereo-viewing and photointerpretation elements.
3. Satellite remote sensing systems, Indian space missions, and digital image interpretation techniques.
4. Applications of satellite Remote Sensing in various fields of Geosciences
5. GIS concepts, data structures, processing, analysis, and applications in geology, along with GNSS technology.

Unit 1: Fundamentals of Remote Sensing: Processes and elements of electromagnetic Remote Sensing – Electromagnetic spectrum and its components – Energy sources and radiation principles – Energy interaction with Earth's atmosphere – Energy interaction with the earth's surface features – Spectral reflectance curve of vegetation, soil and water – Data acquisition, receiving and recording – Outline of thermal, microwave, LIDAR Remote Sensing, and GPR.

Unit 2: Aerial Remote Sensing: Types of aerial photographs – Photographic scale and causes for its variation – Flight planning procedures – Outline of parallax, relief displacement and vertical exaggeration – Stereoscopes: lens and mirror stereoscopes – Annotation of aerial photographs – Elements of photointerpretation – Outline of digital photogrammetry, UAV drone and terrestrial laser scanner.

Unit 3: Satellite Remote Sensing: Types of satellites – Scanning systems and detectors: across-track and along-track scanning systems – Sensor resolution and their types – Sensor characteristics of LANDSAT, SPOT, IRS series of satellites – Outline of high resolution satellites and Hyperspectral Remote Sensing – Indian space programme: past, present and future – Visual image interpretation: elements of image interpretation, image interpretation strategies and keys – Outline of Digital Image Processing techniques.

Unit 4: Remote Sensing Applications in Geology: Lithological mapping – Structural mapping – Mineral exploration – Groundwater exploration – Geomorphic mapping – Land use / land cover mapping – seismic zonation – Landslide zonation – Flood zonation – Soil erosion zonation – Pollution studies.

Unit 5: Geographic Information System (GIS) and Global Navigation Satellite System (GNSS):

GIS: Components – Data structure – Types of Data: raster and vector – Data conversion (Vector to Raster and Raster to Vector) – Spatial data input processes and devices – Entry of non-spatial data – Linking of spatial and non-spatial data – Data verification – Data correction – Data interpolation – Data analysis – Surface modelling – DEM and DTM – Data output – Data quality, errors and their sources – Application of GIS in Geological studies – GNSS: basic concept, structure, applications.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Basic principles of electromagnetic remote sensing, spectral reflectance of Earth's atmosphere and Earth's surface features, and data acquisition receiving and recording process.
2. Aerial Remote Sensing which includes types of aerial photographs, photographic scale and causes for its variations, flight planning missions, stereoscopes and stereo-viewing and photointerpretation elements.
3. Satellite remote sensing systems, Indian space missions, and digital image interpretation techniques.
4. Applications of satellite Remote Sensing in various fields of Geosciences
5. GIS concepts, data structures, processing, analysis, and its applications in geology.
6. Integration of GNSS and GIS applications for spatial data analysis

Text Books:

1. **Allum, J.A.E (1978).** Photogeology and Regional Mapping, Pergamon Press Ltd.
2. **Anji Reddy, M (2001).** Textbook of Remote Sensing and GIS, BSP PS Publications.
3. **Chang, K (2006).** Introduction to Geographic Information Systems. Tata McGraw Hill Pub. Co. Ltd.
4. **Gupta, R.K (2011).** Geographic Information System: Fundamentals and Applications. Arise Publishers.
5. **Gupta, R.P (2008).** Remote Sensing Geology, II Edition, Springer.
6. **Lillesand, T.M., Kiefer, R.W and Chhipman, J.W (2017).** Remote Sensing and Image Interpretation, John Wiley & Sons.
7. **Miller, V.C (1961).** Photogeology. McGraw-Hill Publishers.
8. **Narayan, L.R.A (1999).** Remote sensing and its application. Universities Press Ltd.
9. **Pandey, S.N (1987).** Principles and applications of photogeology. Wiley Eastern Ltd.
10. **Prithvish Nag and S. Sengupta (2008).** Introduction to Geographical Information System. Concept Publishing Company.
11. **Rampal, K.K (1999).** Handbook of Aerial Photography and Interpretation. Concept Publishers Company.
12. **Sabins, F.F (1997).** Remote Sensing Principles and Interpretation, III Edition, W.H. Freeman & Company.
13. **Tor Bernhardsen (2009).** Geographic Information Systems: An Introduction, John Wiley & Sons Inc.

Reference Books:

1. **Barrett, E.C and C.F. Curtis (1982).** Introduction to Environmental Remote Sensing. Chapman & Hall.
2. **Bruno Marcolongo and Franco Mantovam (1997).** Photogeology – Remote Sensing Applications in Earth Sciences, Oxford & IBH Publishers Co. Pvt. Ltd.
3. **Burran, P (1988).** Principles of Remote Sensing. Corgman Publishers.
4. **Heywood, I., Cornelius, S and S. Carver (2010).** An Introduction to Geographic Information Systems, III Edition, Dorling Kindersley (India) Pvt. Ltd.
5. **Jean Yves Scanvic (1997).** Aerospatial Remote Sensing in Geology. Oxford & IBH Publishers Co. .
6. **Lo, C.P and A.K.W. Yeung (2007).** Concepts and Techniques of Geographic Information Systems. Prentice-Hall India Pvt. Ltd.
7. **Siegal, B.S and R. Gillespie (1980).** Remote Sensing in Geology, John Wiley & Sons.

Course Objectives: To impart knowledge on

1. Spectral and physical properties of rocks and minerals and their interpretation for geological mapping and mineral exploration.
2. Mapping various geomorphic features using Remote Sensing data
3. Monitoring surface and groundwater and, land use/land cover analysis using Remote Sensing data
4. Role of Remote Sensing for assessing natural hazards such as floods, landslides, earthquakes, etc.
5. Role of Remote Sensing for shoreline change, oil spill mapping, and habitat mapping.

Unit 1: Remote Sensing Applications in Geology: Spectral properties of rocks and minerals, elemental composition and spectra of rocks and minerals, physical properties and spectra, optimal spectral windows – Mapping of rock types – Mapping of geological structures: folds, faults, fractures / lineaments – Mineral exploration – Land and water degradation due to mining activity.

Unit 2: Remote Sensing Applications for Geomorphic Mapping: Mapping of Structural landforms – Denudational landforms – Fluvial landforms – Aeolian landforms – Coastal landforms – Drainage networks and patterns.

Unit 3: Remote Sensing Applications for Water Resource Studies and Land Use/ Land cover Analysis: Mapping and monitoring of surface water bodies – Monitoring of quality of surface water bodies – Groundwater potential zonation mapping in unconsolidated and hard rock areas - Land Use/ Land cover Analyses: Remote Sensing Applications in: Land use/Land cover classification system of USGS and NRSC – Mapping of land use/ land cover classes.

Unit 4: Remote Sensing Applications for Natural Disaster Studies: Mapping of flood prone and, flood affected areas – Mapping of earthquake prone and, earthquake affected areas – Mapping of volcanic eruption prone areas – Mapping of landslide prone areas, and landslide affected areas – Mapping of soil erosion prone areas.

Unit 5: Remote Sensing Applications for Coastal Applications: Mapping of erosion prone areas – Shoreline change analysis – Coastal wetland mapping – Oil spill mapping – Mapping of coral reef habitat – Mapping of mangrove habitats.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Spectral and physical properties of rocks and minerals and their interpretation for geological mapping and mineral exploration.
2. Mapping various geomorphic features using Remote Sensing data
3. Monitoring surface and groundwater and, land use/land cover analysis using Remote Sensing data
4. Role of Remote Sensing for assessing natural hazards such as floods, landslides, earthquakes, etc.

5. Role of Remote Sensing for shoreline change, oil spill mapping, and habitat mapping.
6. Integrate knowledge from multiple remote sensing applications in geosciences for research and professional development.

Text Books:

1. **Lillesand, T.M., Kiefer, R.W and Chapman, J.W (2015).** Remote Sensing and Image Interpretation (VII Edition), John Wiley & Sons Inc.
2. **Gupta, R.P (2008).** Remote Sensing Geology (II Edition), Springer.
3. **Boris Escalante-Ramirez (2012).** Remote Sensing – Applications, InTech Pub.

Reference Books:

1. **Bruno Marcolongo and Franco Mantovam (1997).** Photogeology – Remote Sensing Applications in Earth Sciences, Oxford & IBH Publishers Co. Pvt. Ltd.
2. **Sabins, F.F (2007).** Remote Sensing Principles and Interpretation (III Edition), Waveland Pr. Inc.
3. **Wang, Y (2010).** Remote Sensing of Coastal Environments. CRC Press, Taylor & Francis Group.

COURSE OBJECTIVES:

- To introduce the basic concepts of Artificial Intelligence and Machine Learning and their relevance in geological studies
- To enable students to understand the application of AI/ML techniques in mineral exploration, resource prediction, and geological mapping
- To develop skills in using GIS, remote sensing, and Python-based tools for geoscientific data analysis To familiarize students with AI applications in seismic interpretation, groundwater modeling, and environmental geology.
- To prepare students for modern geoscience careers by integrating computational techniques with traditional geological methods.

UNIT 1: Introduction to Artificial Intelligence: Definition of Artificial Intelligence; history and evolution of AI; types of AI (narrow, general, strong AI); applications of AI in Earth sciences and geology; basic concepts of machine learning; data types and data preprocessing; introduction to Python for AI; overview of AI tools used in geosciences.

UNIT II : Machine Learning Fundamentals: Supervised, unsupervised, and reinforcement learning; regression and classification techniques; clustering methods; decision trees and random forests; support vector machines; model training and testing; evaluation metrics (accuracy, precision, recall); applications in mineral exploration and geological data analysis.

UNIT III : Data Science & Geospatial Analysis: Introduction to data science in geology; role of GIS and remote sensing in AI; spatial data formats and analysis; image classification techniques; use of Python libraries such as NumPy, Pandas, and GeoPandas; satellite image processing; geological mapping using AI techniques.

UNIT IV: AI Applications in Geology: AI in mineral and petroleum exploration; seismic data interpretation using machine learning; groundwater potential zoning; landslide and hazard prediction; environmental monitoring; structural geology and lithological classification using AI; case studies in geoscience applications.

UNIT V: Advanced Topics & Tools in AI for Geosciences: Deep learning concepts (neural networks, CNN, RNN basics); AI tools such as TensorFlow and PyTorch; cloud-based AI platforms (Google Earth Engine, ArcGIS AI tools); automation in geological mapping; integration of AI with GIS and remote sensing; future trends of AI in Earth sciences

COURSE OUT COMES:

1. Understand: Students will be able to explain the fundamental concepts of Artificial Intelligence, Machine Learning, and their relevance to Earth and geological sciences.
2. Evaluate: Students will evaluate the effectiveness of AI techniques in solving geological problems such as mineral exploration, seismic interpretation, and hazard prediction
3. Apply: Students will apply basic machine learning algorithms such as classification, regression, and clustering to geological datasets.
4. Create: Students will develop simple AI/ML models and integrate them with GIS and remote sensing data for geological applications.

TEXT BOOKS:

1. Petrelli, M., Machine Learning for Earth Sciences: Using Python to Solve Geological Problems, Springer, 1st Edition, 2023
2. Moseley, B. & Krischer, L. (Eds.), Machine Learning and Artificial Intelligence in Geosciences, Elsevier, 2020
3. Cranganu, C. (Ed.), Artificial Intelligent Approaches in Petroleum Geosciences, Springer, 2nd Edition, 2024
4. Mallick, S., Computation, Optimization, and Machine Learning in Seismology, Wiley, 1st Edition, 2025
5. Chen, W. et al., Remote Sensing Intelligent Interpretation for Geology, Springer, 1st Edition, 2024

REFERENCES BOOKS

1. Petrelli, M., Machine Learning for Earth Sciences: Using Python to Solve Geological Problems, Springer, 2023
2. Petrelli, M., Machine Learning for Earth Sciences: Using Python to Solve Geological Problems, Springer, 2023 Cranganu, C. (Ed.), Artificial Intelligent Approaches in Petroleum Geosciences, Springer, 2nd Edition, 2024.

COURSE OBJECTIVES:

To learn about the basics of Geology, branches of Geology, Solar system, earthquake, volcanoes, continents and Ocean, tectonic process, mountains, major types of rocks and minerals.

UNIT-I:

Definition of Geology–Branches of Geology–The Solar system:–Origin of Earth - Nebular hypothesis – Planetesimal hypothesis – Tidal hypothesis – VonWeiszacker’s hypothesis-Dust Cloud hypothesis-Big bang theory. Detailed study of the structure and composition of Earth’s interior.

UNIT-II:

Earthquakes and Volcanoes: Definition — Focus and Epicenter – Magnitude and Intensity – seismic waves – Seismograph and Seismogram – Distribution of Earthquakes in India–Prediction of Earthquakes–Tsunami.

UNIT-III:

Volcanoes: Definition – Types, –Distribution of volcanoes, Causes of volcanism– Effects of Volcanic activity–Prediction of volcanoes.

UNIT-IV:

Distribution of continents and Oceans –Continental drift: Wegner’s and Taylor’s hypothesis–Merits and demerits of drift theories; Seafloor spreading- Concept of plate tectonics – Different kinds of plate margins.

UNIT-V:

Quartz and Feldspar group of Minerals, Origin of Igneous, Metamorphic and Sedimentary rocks and its distribution in Tamil Nadu.

UNIT -VI: CURRENT CONTOURS (For Continuous Internal Assessment only):

Asteroids, meteorites, recent earth quake occurrences, volcanic eruptions-sea level rise - Mineral wealth of Tamil Nadu.

REFERENCES:

1. Arthur Holmes (1992) Principles of Physical Geology: Thomas Nelson & sons London.
2. Philip G. Worcester (1939) A text book of geomorphology: D. Van Nostrand Co., London.
3. Radhakrishnan V (1966). General Geology- V. V. P. Press.
4. Mahapatra, G. B. (2015) A text book of Geology (-CBS, Delhi
5. Patwardhan, A. M. (2012) The Dynamic Earth System- PHI Learning PVT. Ltd, New Delhi

6. William J. Miller (1949) - Principles of physical Geology - Thomas Nelson & sons, London.
7. W.D. Thornbury (1969) A text book of geomorphology - D. Van Nostrand Co., London.
8. A.L. Bloom (1978) General Geology - V.V.P. Press.
9. L.D. Leet & Judson (1960) Physical Geology - Prentice Hall, India.
10. Edger W. Spencer Earth Science (2002) - McGraw Hill, New Delhi.
11. Richard John Huggett, 2016, Fundamentals of Geomorphology, Taylor and Francis, Fourth edition
12. Vishwas .s.kale and Avijit Gupta, 2018, Introduction to Geomorphology, The orient black swan Publications
13. Michael A. Summerfield, 2011 Geomorphology and global tectonics, John Wiley Publications
14. Siva Nand Jha, 2021, A Handbook of Geomorphology, Shree Navman Publications
15. Ajit Kumar Sil, 2021, Global tectonics and Geomorphology, Himalayan books.

SECOND YEAR

**CORE COURSE 7
ECONOMIC GEOLOGY**

Semester IV

Code

CREDIT: 4

COURSE OBJECTIVES:

To study about the Materials of mineral deposits its Magmatic processes, Sedimentary and metamorphic processes of economic minerals, Fossils, fuels uses, origin and distribution in India and important oilfields of India.

Unit 1: Economic Geology: Processes of formation of mineral deposits: Magmatic concentration – Sublimation – Contact metasomatism – Hydrothermal (Cavity, filling and replacement) – Sedimentation – Evaporation – Residual and Mechanical Concentration – Oxidation and Supergene Enrichment – Metamorphism.

Unit 2: Classification of mineral deposits – Controls of ore localization: structural, stratigraphic, physical and chemical controls – Metallogenic epochs and provinces – Plate tectonics and ore genesis – Geologic thermometry – Geobarometry – Stable and radiogenic isotopes of ores and the host rocks – Fluid inclusion in ore mineral assemblages: Physical and chemical properties, micro thermometry.

Unit 3: Origin, mode of occurrence, Indian distribution and uses of the following metallic minerals: Iron, Manganese, Copper, Lead and Zinc, Chromium, Gold, Aluminium and Graphite.

Unit 4: Origin, mode of occurrence, Indian distribution and uses of the following ores: Asbestos, Barite, Graphite and Magnesite – Mineralogy, origin, mode of occurrence, Indian distribution of minerals used in refractory, fertiliser, ceramic, cement, glass, paint, abrasive industries.

UNIT-5: Introduction to Strategic, Critical and essential minerals. National mineral policy and their role in National economy. Mineral based Industries in India. Geology, Mode of Occurrence and Origin of the raw materials of the following Industries: Refractory- Abrasives-paint and pigments-fertilizer glass, ceramic and cement industries.

Course Outcomes (COs): On completion of the course the student would have gained knowledge on

1. Classification of mineral deposits, controls of ore localization, metallogenic epochs and provinces
2. Ore forming processes such as magmatic process, sublimation, metasomatism, hydrothermal processes, Oxidation and supergene sulphide enrichment, Metamorphic processes, Sedimentary processes and cycles, Mechanical concentration
3. Salient features of coal, petroleum, and nuclear minerals.
4. Important metalliferous ore deposits in India, their composition, mode of occurrence, and uses.
5. Important industrial minerals, building stones
6. Tamil Nadu's mineral wealth.

Text Books:

1. **Bateman Allan, M (1962).** Economic Mineral Deposits (II Edition), Asian Publishing House.
2. **Deb, S (1980).** Industrial Minerals and Rocks of India, Allied.
3. **Krishnaswamy, S (1979).** India's Mineral Resources, Oxford and IBH.
4. **Lindgren, W (1933).** Mineral Deposits, MCGraw Hill.
5. **Umeshwar Prasad (2019).** Economic Geology (II Edition), CBS Publishers.

Reference Books:

1. **Coggin, B and A.K. Dey (1955).** India's Mineral Wealth, Oxford Publishing House.
2. **Gokhale, K.V.G.K. and T.C. Rao (1978).** Ore Deposits of India, their Distribution and Processing, Thomson.
3. **Park, C.F and R.A. Macdiarmid (1970).** Ore Deposits, Freeman.

Course Objectives: To impart knowledge on

1. Hydrological cycle, origin and occurrence of groundwater, hydrological properties of aquifers, aquifer types, and factors influencing groundwater distribution in different rock types.
2. Groundwater movement, apply Darcy's law in various media, determine hydraulic conductivity, and examine groundwater fluctuations and their causes.
3. Types of wells, their construction, development, and analysis of well performance using various methods.

Unit 1: Occurrence and Distribution of Groundwater: Origin of water on Earth – Hydrological cycle – Genesis of groundwater – Vertical distribution of groundwater – Hydrologic properties of aquifers – Geologic formations as aquifers: porosity, permeability and hydraulic conductivity and their ranges in representative rocks – Groundwater occurrence in igneous rocks, sedimentary rocks, metamorphic rocks, consolidated and unconsolidated sediments – Natural and artificial discharge of groundwater: springs, hot springs, geysers, water wells, and artesian wells.

Unit 2: Groundwater Movement and Groundwater Levels: Darcy's Law: experimental verification and validity; Darcy's Law in homogenous, heterogenous, isotropic and anisotropic media – Reynold's number and Bernoulli equation – Field and laboratory determination of hydraulic conductivity – Groundwater flow: rates, direction, dispersion and diffusion – Flow line and flow nets – Groundwater table mapping and Groundwater potential zonation – Groundwater fluctuations: causes and effects – Impacts of global climatic change on groundwater.

Unit 3: Water Wells and Well Hydraulics: Water wells: shallow wells and deep wells – Construction of a well: well drilling and well completion – Well development through pumping, bridging, surging with air, back washing, acidizing – Protection of well through sealing – Pumping test: Theis's method, Theim's method, Copper-Jacob's method, Chow's method – Well flow near aquifer boundaries.

Unit 4: Groundwater Exploration and Management: Geomorphological, structural and biological indicators of groundwater – Surface investigation methods of groundwater: remote sensing, electrical resistivity – Sub surface investigation methods of groundwater; test drilling, resistivity logging – Tracer-Isotope techniques–Managing groundwater resources: estimation of groundwater recharge and discharge, groundwater budget, residence time concept – Artificial recharge methods – Groundwater basin investigations and management practices – Groundwater regime in India. Rainwater harvesting techniques.

Unit 5: Groundwater Quality: Groundwater composition and units of expression, mass-balance calculations – Rock water interaction: chemical equilibrium, free energy, redox reactions and cation / anion exchanges – Graphic representation of chemical data – Latest drinking water quality standards of WHO and BIS – Outline of irrigation water quality standards – Groundwater quality contamination – Sea-water intrusion: causes, effects, methods of their study and their control – Groundwater issues due to urbanization–Groundwater Modelling: solid and liquid waste disposal and plume migration models – Application of tracer (Tritium, Radon), isotope (H, C, O) techniques in groundwater – Major basins and drainage systems of Tamil Nadu–Groundwater scenario in India with special reference to Tamil Nadu.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The origin, hydrological cycle, and occurrence of groundwater in various geological formations.
2. Application of Darcy's law and analysis of groundwater flow characteristics and fluctuations under natural and climatic influences.
3. The construction and development of wells and apply well hydraulics for determining aquifer characteristics.
4. Geomorphological, geophysical, and isotope techniques in groundwater exploration and application of principles of groundwater management.
5. Assessment of groundwater quality, contamination processes, and interpret water quality standards and seawater intrusion control measures.
6. Hydrogeological models and isotopic tools to understand contamination patterns, recharge processes and, groundwater status in India with special reference to Tamil Nadu.

Text Books:

Gokhale, N.W (2009). All about Water, CBS Publishers.

1. **Raghunath, H.M (2007).** Groundwater, Wiley Eastern Limited.
2. **Ramakrishnan, S (1998).** Groundwater, KJ Graphs Arts.
3. **Saxena,R. N. and Gupta, D. C (2017).** Elements of Hydrology and Groundwater, PHI Learning Private Ltd.
4. **Todd, D.K (2005).** Groundwater Hydrology, Wiley India Pvt. Ltd.

Reference Books:

1. **Fetter, C.W (2007).** Applied Hydrogeology, CBS Publishers.
2. **Hamid Rizvi, S.M (2015).** Geomorphology and Hydrogeology, Kalyani Publishers.
3. **Sankar Kumar Nath (2000).** Geophysical Prospecting for Groundwater, Oxford and IBH.
4. **Sathya Prakash Garg (1993).** Groundwater and Tube Wells, Oxford University Press.

Course Objectives: To impart knowledge on

1. The stages of geological exploration, prospecting methods, field documentation, sampling techniques, and ore reserve estimation.
2. The principles and applications of electrical, magnetic, electromagnetic, and well-logging techniques in geophysical exploration.
3. Principle, instrumentation, data collection and interpretation involved in gravitational, seismic, and radioactive methods used in geophysical surveys.
4. Geochemical principles, elemental classifications, geochemical cycles, and survey methodologies.
5. Methods of various geochemical and biogeochemical survey methods, geobotanical indicators, and their role in mineral exploration.

Unit 1: Geological Exploration: Stages of exploration – Scope, objectives and methods of prospecting, regional exploration and detailed exploration – Criteria controlling the choice of sites for geological prospecting – Marginal information of toposheets and study of field equipments – Field documentation and basic field procedures – Sampling (pitting, trenching, drilling), assaying and ore reserve estimation techniques – Categorization of ore reserves – Outline on exploratory mining – Ore controls as guides: mineralogical, structural, stratigraphical and geomorphological guides to ore search – Geological methods of surface and sub-surface exploration on different scales.

Unit 2: Geophysical Exploration: Outline on geophysical methods of exploration – Electrical methods: resistivity, self-potential and induced polarization methods, their principles, field procedures, instruments used, applications and limitations – Magnetic method: magnetic properties of rocks and minerals, Earth's magnetic field, regional and local anomalies, instruments used in exploration, procedures in field survey, interpretation of data, applications – Electromagnetic method: principles, instruments used, field procedures, interpretation of data, and applications, outline on magneto-telluric technique – Well logging techniques and their applications.

Unit 3: Gravitational method: Earth's gravitational field, geoid, principles, instruments used in exploration, field procedures, corrections, interpretation of data, applications and limitations – Seismic method: seismic refraction and reflection methods – principles, field procedures (data acquisition), data processing, data interpretation, and applications – Radioactive method: Radioactive decay, radioactivity in rocks and minerals, instruments used in exploration, procedures in field survey, interpretation of data, applications.

Unit 4: Geochemical Exploration: Origin of elements and abundance of elements in the earth's crust – Classification of elements: major, minor, trace and rare earth elements – Principles of geochemical prospecting: Geochemical cycle, geochemical environments, geochemical dispersion, geochemical mobility, geochemical anomalies and path finder elements – Geochemical survey: reconnaissance surveys and detailed surveys – Stages of a geochemical survey: planning, sampling, analysis, geochemical map, anomaly and interpretation.

Unit 5: Methods of Geochemical survey: lithogeochemical surveys, hydrogeochemical surveys, pedogeochemical surveys (stream sediments, lake sediments, glacial sediments, heavy minerals) – Biogeochemical exploration: principles, sampling, chemical analysis and interpretation of

anomalies – Geobotanical indicators for mineral prospecting – Applications of Geochemistry in mineral exploration.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The stages, scope, and field procedures involved in geological exploration.
2. Electrical, magnetic, electromagnetic, and well-logging methods in geophysical exploration.
3. Gravitational, seismic, and radioactive techniques for data acquisition and interpretation.
4. Geochemical principles, geochemical anomalies, and plan geochemical surveys effectively.
5. Interpretation of lithogeochemical, hydrogeochemical, pedogeochemical, and biogeochemical data in mineral exploration.
6. Integration of geological, geophysical, and geochemical exploration methods for effective mineral resource assessment.

Text Books:

1. **Bateman, A. M (1995).** Economic Mineral Deposits, Willey.
2. **Dhana Raju, R (2009).** Handbook of Mineral Exploration and Ore Petrology: Techniques and Applications, Geological Society of India.
3. **Mason, B and C. B. Moore (1982).** Principles of Geochemistry (IV Edition), John Wiley & Sons.
4. **Misra, K. C (2012).** Introduction to Geochemistry: Principles and Applications, Wiley-Blackwell.
5. **Misra, K. C (2012).** Understanding Mineral Deposits, Kluwer Academic Publishers.
6. **Ramachandra Rao, M. B (1975).** Outlines of Geophysical Prospecting: A Manual for Geologists, Prasaranga, University of Mysore, Mysore.
7. **Sharma, P.V (2004).** Geophysical Methods in Geology, Elsevier Inc.

Reference Books:

1. **Burger, H. R (1992).** Exploration Geophysics of the Shallow Subsurface, Prentice Hall.
2. **Dobrin, M. B (2001).** Introduction to Geophysical Prospecting, McGraw Hill Inc.
3. **Edwards, R and K. Atkinson (2013).** Ore Deposits Geology and its Influence on Mineral Exploration, Springer.
4. **Ginzburg, I. I (2013).** Principles of Geochemical Prospecting: Techniques of Prospecting for Non-Ferrous Ores and Rare Metals, International Series of Monographs on Earth Sciences, Volume 3, Pergamon.
5. **Govett, G. J. S (2013).** Hand Book of Exploration Geochemistry, Elsevier Science.
6. **Kearey, P. and M Brooks (1989).** An Introduction to Geophysical Exploration, English Language Book Society / Blackwell Scientific Publications.
7. **Kovalevsky, A. L (1987).** Biogeochemical Exploration for Mineral Deposits, VNU Science Press.
8. **Levinson, A.A (1976).** Introduction to Exploration Geochemistry, Applied Publication Co.
9. **Lowrie, W (1997).** Fundamentals of Geophysics, Cambridge.
10. **Marjoribanks, R (2010).** Geological Methods in Mineral Exploration and Mining (II Edition), Springer.
11. **Moon, C. J., Whateley, M. K. G. and A. M. Evans (2006).** Introduction to Mineral Exploration (II Edition).
12. **Raman, P. K (1989).** Principles and Practices of Mineral Exploration: A Professional Manual, Geological Society of India,
13. **William, W. M (2014).** Isotope Geochemistry, Wiley.

SECOND YEAR DISCIPLINE CENTRIC ELECTIVE COURSE –IV SEMESTER – IV

1. FUEL GEOLOGY

Code

Credit: 4

Course Objectives:

To impart knowledge on

1. Understanding the geological processes involved in the formation and alteration of coal, including its petrographic constituents and geological settings.
2. Coal properties, classification systems, and its potential as a fuel and energy source including CBM.
3. Petroleum origin theories, reservoir and trap characteristics, and the geological distribution of oilfields.
4. Exploration techniques for hydrocarbons including drilling, logging, reserve estimation, and economic considerations.
5. Geology, occurrence, and utilization of nuclear fuels and non-conventional energy resources

Unit 1: Coal Geology: Origin of coal: peat formation and its environments, biochemical peatification, geochemical coalification, causes of coalification, coal maturity and diagenesis – Post depositional changes of coal seams – Coal Geology: sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams – Coal formation in geological space and time – Petrography of coal: lithotypes, micro-lithotypes and macerals and their applications.

Unit 2: Physical properties of coal – Chemical composition of coal – Chemical analysis of coal: proximate and ultimate analysis – Classification of coal: Indian classification and International classifications (I.S.O. classification) – Classification of coal in terms of rank, grade and type – Outline of underground coal gasification, coal as an oil prone rock, coal as a liquid fuel – Geological and geographical distribution of coal and lignite deposits of India – Outline of Coal Bed Methane (CBM).

Unit 3: Petroleum Geology: Petroleum: constituents and composition – Origin of petroleum: organic and inorganic, evidences in their favour and against – Formation and migration of petroleum – Reservoir rocks: porosity and permeability – Reservoir traps: structural, stratigraphic and combination traps – Oilfield fluids: water, oil and gas – Applied stratigraphy – facies, sequence and depositional environment – An outline of oil belts of the world and India – Sedimentary basins of India – Petroliferous basins of India – Geology of productive oilfields of India.

Unit 4: Prospecting methods for oil and gas: geological, geophysical (seismic) and geochemical methods – Micropaleontology in petroleum exploration – Oil and gas reserve estimation – Proved, probable and possible reserves – Deterministic methods – Drilling and logging procedures – Drilling RIG: components, concepts and operational procedures – Electrologs: principles, procedures and interpretation – Mudlogging units: basic concepts and utilities – Reservoir studies: principles – Oil recovery: enhanced oil recovery techniques (chemical methods, miscible methods,

thermal method – Petroleum management and economics – Oil shale – Gas hydrates - Oil policy of India.

Unit 5: Nuclear and Non-conventional Energy Resources: Radioactive minerals: mineralogy, chemistry, geological characteristics, mode of occurrence, genesis of major types of atomic minerals – Metallogenic epochs and provinces of uranium mineralisation – Distribution of nuclear fuel deposits in India – Lithium: uses and, occurrences in India – Geothermal energy: principles of utilization of Earth's heat, types of geothermal source, geothermal energy sources in India, future scenario of geothermal energy in India.

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Origin, peatification, and coalification processes and interpret coal petrography.
2. Classification of coal based on rank, grade, and type; perform and interpret coal analyses.
3. The formation and migration of petroleum and characteristics of reservoir rocks and traps.
4. The methods for petroleum exploration and oil recovery, electrologs, and oilfield management.
5. Geological and geographical distribution of energy resources in India and abroad.
6. Genesis and occurrence of nuclear fuels and analyze the potential of non-conventional resources.

Text Books:

1. **Aswathanarayana, U (1985).** Principles of Nuclear Geology, Oxford Press.
2. **Chandra, D., Singh, R.M and M. P. Singh (2000).** Textbook of Coal (Indian Context), Tara Book Agency.
3. **Chandrasekharam, D (2005).** Geothermal Energy Resources of India: Past and the Present, World Geothermal Congress.
4. **Dhana Raju, R (2005).** Radioactive Minerals, Economic Geology series, Geological Society of India.
5. **Holson, G. D and E. N. Tiratso (1985).** Introduction to Petroleum Geology, Gulf Publishing.
6. **Larry Thomas (2013).** Coal Geology, John Wiley & Sons.
7. **Levorsen, T (1999).** Geology of Petroleum (II Edition), CBS Publishers and Distributors.
8. **Saxena, V. K (2004).** Geothermal Resources of India, Allied Publishers Pvt. Ltd.
9. **Selley, R.C (1998).** Elements of Petroleum Geology, Academic press.

Reference Books:

1. **Boyle, R.W (1982).** Geochemical Prospecting for Thorium and Uranium Deposits, Elsevier.
2. **Cataldi, R and M. C. S. Arrriaga (2020).** History of Geothermal Energy in the World to the 20th Century, ThinkGeoEnergy.
3. **Dahlkamp, F.J (1993).** Uranium Ore Deposits, Springer Verlag.
4. **Doveton, J.H (1994).** Geological Log Interpretation, SEPM, Tulsa.
5. **Henry, G (1994).** Geophysics of Sedimentary Basins, Technip, Rue Ginoux.
6. **Isabel Suárez-Ruiz and John C. Crelling (2008).** Applied Coal Petrology: The Role of Petrology in Coal Utilization, Academic Press.
7. **Lewis, D. W and D. McConchie (1994).** Analytical Sedimentology, Chapman & Hall.

8. **North, F.K (1985).** Petroleum Geology, Allen Unwin.
9. **Pohl Walter (2011).** Economic Geology: Principles and Practice: Metals, Minerals, Coal and Hydrocarbons - Introduction to Formation and Sustainable Exploitation of Mineral Deposits, John Wiley & Sons.
10. **Ravi Shankar Guha, S. K., Seth, N. N., Muthuraman, K., Pitale, U. L., Jangi, B. L., Prakash, G., Bandopadhyay, A. K and R. K. Sinha (1991).** Geothermal Atlas of India, Special Publication No.19, GSI.
11. **Singh, M.P (1998).** Coal and Organic Petrology, Hindustan Publishing Corporation.
12. **Sircar, A. and K. Yadav (2019).** Harnessing Geothermal Energy Applications in India, Technology Publications.
13. **Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichmuller, M. and R. Teichmuller (1982).** Stach's Textbook of Coal Petrology, GebruderBorntraeger, Stuttgart.
14. **Yates, M (1980).** Earth Power: The Story of Geothermal Energy, Abingdon Publishers.

Course Objectives: To impart knowledge on

1. The principles of petroleum geology, drilling methods, borehole calculations, and well operations including testing and completion.
2. The basics of mudlogging, geological surveillance, cutting examination, hydrocarbon shows, and safety standards in worksite environments.
3. Mudlogging sensors, maintenance, operations, reporting, and practical lab training in rig activities.
4. Advanced down-hole measurements using MWD tools including resistivity, gamma ray, porosity, density, and geosteering technologies.
5. Logging while drilling (LWD) techniques, interpretation of logs, and sequence stratigraphy for reconstructing depositional environments.

Unit 1: Petroleum Exploration – Petroleum Geology – Applied Mathematics in Petroleum Engineering – Oil Field Drilling: onshore and offshore drilling – Drilling rigs – Well types – The drill string – Drill bits – Well Profile – Bore-hole volume calculation and displacement – Lag time – Basic hydraulics – Drilling fluids – Formation pressure – Bore hole problems – Coring: objective of coring and core Analysis – Casing and Cementing – Fishing – Well completion – Well testing.

Unit 2: Basics of Mudlogging – Surface Logging – Tasks and Responsibilities – Geological Surveillance – Cutting Sampling – Collection, Examination – Lithological and mineralogical description – Calcimetry – Oil Shows – Fluorescence and cut fluorescence – Thin sections – Chemical tests – Gas sampling – Hydrocarbon gas analysis – Pore pressure calculation – Cutting evaluation – Sample examination procedure – Well site Geochemistry – Gases other than hydrocarbons – Communication skill – QHSE – Worksite environmental hazards – Offshore Safety – Quality control.

Unit 3: Mudlogging services, Mudlogging sensors – Operations – Maintenance – Inspection and calibrations – Trouble shooting – Technical specification – Reporting – Final well reports – Mud logging unit Installation and maintenance – Practical mudlogging, lab training on Rig up and Rig Down of sensors, equipment and monitoring realtime drilling followed by a Rig site visit.

Unit 4: Down-hole Measurement – Measuring While Drilling (MWD): MWD Principle – Telemetry types – Formation evaluation MWD-Sensor information – Natural gamma ray – Formation resistivity – Focused Current Resistivity (FCR) – Toroidal Resistivity – Electromagnetic wave Propagation resistivity – Multiple Propagation Resistivity (MPR) – Geo-Steering – Neutron Porosity MWD Tools – Formation Density MWD Tools – Drilling Performance MWD.

Unit 5: Down-hole Logging – Logging While Drilling (LWD) – Temperature logs – Caliperlogs – Self Potential Logs (SP) – Resistivity and Conductivity Logs – Gamma ray and Spectral Gamma

ray logs – Sonic Logs – Density and Photo Electric factor Logs – The Neutron Log – The dip meter – Imaging Logs – MDT Sampling – Lithology reconstruction from Logs – Facies Sequences and depositional environments from Logs – Sequence Stratigraphy and Stratigraphy..

Course Outcomes: On completion of the course the student would have gained knowledge on

1. Fundamentals of petroleum geology and drilling operations including well completion and testing.
2. Mudlogging techniques, geological sampling, and safety protocols at drilling sites.
3. Mudlogging unit operations, equipment calibration, and sensor monitoring in practical scenarios.
4. Down-hole measurements using MWD tools and interpret sensor data for formation evaluation.
5. Types of LWD logs and reconstruct lithology, facies, and depositional environments.
6. Integrating theoretical knowledge with field applications to evaluate well performance and stratigraphy using real-time data.

Text Books:

1. **Stamp L.D, (1964).** An Introduction in Stratigraphy, Thomas Murby, Museum St, WCI.
2. **Bhagwan Sahay. (1997).** Petroleum Exploration and Exploitation Practices, Allied Publishers, II Ed.
3. **Geological Survey of India (2005).** Geology & Mineral Resources of the States of India. Misc. Pub. No. 30.
4. **Levorsen, A.J. (2004).** Geology of Petroleum, CBS Publishers and Distributors Pvt Ltd., II Ed.
5. **Wadia, D.N (1953).** Geology of India, McMillan India.

Reference Books:

1. **Brian Frehner (2011).** Finding Oil: The Nature of Petroleum Geology, 1859–1920, University of Nebraska Press.
2. **Mudlogging Training Manuals (2020)** – GEOLOG International B.V
3. **Weller, J.M (1962).** Stratigraphic Principles and Practices, Harper & Bros.

COURSE OBJECTIVES:

- To understand the Physical, Chemical and Optica; properties of Gemstones

UNIT I : Introduction to gemmology, basic qualities (hall marks), Chemical Composition, Weights and measures. Factors that influence the value of gemstones, beauty, durability, rarity and acceptability.

UNIT II: Chemical properties of Gemstones: Chemical bonding and crystallography – atomic structure, types of Chemical bonds, shape of molecules, crystalline and amorphous materials, crystal symmetry, crystal forms, crystal habits, seven crystal systems, twinning, isomorphous substitution, crystalline polymorphism.

UNIT III: Physical properties of gemstones. Hardness-Definition, Moh's scals, selection of reference minerals, application in gemmology, limitations of use Cleavage –Definition, description, importance in gemology and lapidary work. Specific gravity – Definition, Determination, hydrostatic weighing, the use of high destroy liquids in gem testing, flotation and pycnometer method

UNIT IV: Optical properties of gemstone– Importance of light in gemmology, the electromagnetic spectrum, the visible region. Transparency -Laws of refraction, refractive index, reflection and its effects, refractometer, birefringence and its determination. Polarized light – Nature and production, isotropic and anisotropic behaviour, optic axes – Design and construction of polariscope use of polariscope in gemmology. Absorption of light, allochromatism, idiochromatism, differential absorption of light, pleochroism, Dichroscope-construction and use, Interference and diffraction, play of colour, dispersion, use the Chelsea colour filter, luminescence.

UNIT V: Apparatus for gem identification Use of 10 x lens and balance, description of the microscope and an awareness of its other applications and use as a magnifier, design, construction and use of spectroscope Absorption spectra of typical gem materials. Use of ultraviolet lamps. Thermal and electrical conductivity and probes, reflectance meters. Brief study on the use of gem testing, Infrared, ultraviolet and X-ray instruments. gnation, coating, heat treatment, irradiation, laser treatment, fracture filling and diffusion treatment.

COURSE OUTCOMES:

- Distinguish gemstones from synthetics and imitations.

REFERENCES

1. Beginners guide to Gemmology by P.G.Read
2. Practical Gemmologer by R.Webstar
3. Gem Testing by S.W. Anderson
4. Gemstones of the world by W.Schumann.

Unit 1: Geochemical analysis: Qualitative analysis and quantitative analysis – Sampling and sample preparation – Dissolution procedures for geologic samples – Principles, applications and limitations of the following instruments: Atomic Absorption Spectrometry (AAS), Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES), X-Ray Fluorescence Spectrometry (XRF).

Unit 2: Principles, applications and limitations of the following instruments: Gas Source Mass Spectrometry (GSMS), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Spark Source Mass Spectrometry (SSMS), Accelerator Mass Spectrometry (AMS), Thermal Ionisation Mass Spectrometry (TIMS), Secondary Ion Mass Spectrometry (SIMS).

Unit 3: Principles, applications and limitations of the following instruments: Scanning Electron Microscope (SEM), Electron Probe Microanalysis (EPMA), Neutron Activation Analysis (NAA), Liquid Chromatography (LC), Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC).

Unit 4: Principles and applications of the following instruments used for crystallography and mineralogy: X-Ray Diffraction, Reflectance and Emission Spectroscopy, Thermal Emission Spectroscopy, Mossbauer Spectroscopy, Laser Raman Spectroscopy.

Unit 5: Principles, types, field procedure and application of the instruments used for the following geophysical surveying techniques: Gravity methods, Magnetic methods, Seismic methods, Resistivity methods and Radioactivity methods

Course Outcomes: On completion of the course the student would have gained knowledge on

1. The principles and working mechanisms of geochemical analysis instruments (AAS, ICP-AES, XRF).
2. The functionalities and limitations of advanced mass spectrometry instruments (GSMS, ICP-MS, SSMS, AMS, TIMS, SIMS).
3. Describe and Applications of the concepts of SEM, EPMA, NAA, and chromatography techniques in geosciences.
4. Applications of crystallography and mineralogical instruments like XRD, Raman, and Mossbauer spectroscopy.
5. Interpretation of data obtained through geophysical surveys using instruments for gravity, magnetism, resistivity, seismic, and radiometric methods.
6. Integrating the knowledge of analytical and geophysical techniques for applied geological research and environmental problem-solving.

Text Books:

1. **Douglas A. Skoog, James Holler, F., Stanley and R. Crouch (2016).** Principles of Instrumental Analysis (VII Ed.), Cengage Learning.
2. **Francis Rouessac, and Annick Rouessac (2007).** Chemical Analysis - Modern Instrumentation Methods and Techniques, Wiley.
3. **Robinson, E.S. and C. Coruh (2002).** Basic Exploration Geophysics, John Wiley.
4. **The Lord Energlyn and L. Brealey (1971).** Analytical Geochemistry, Academic Press, Elsevier.
5. **Ramachandra Rao, M. B (1975).** Outlines of Geophysical Prospecting - A Manual for Geologist, Prasaraanga, University of Mysore.

Reference Books:

1. **Baedecker, P. A (1987).** Methods for Geochemical Analysis. U.S. Geological Survey Bulletin.
2. **Dobrin, M. B (2001).** Introduction to Geophysical Prospecting, McGraw Hill Inc.
3. **Keare, P and M. Brooks (1999).** An Introduction to Geophysical Exploration, Blackwell Scientific Publications.
4. **Potts, P.J (1995).** Microprobe Techniques in the Earth Sciences, Mineralogical Society (Great Britain) Chapman & Hall.
5. **Robin Gill (2014).** Modern Analytical Geochemistry - An Introduction to Quantitative Chemical Analysis Techniques for Earth, Environmental and Materials Scientists, Routledge.