ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF EARTH SCIENCES

M. Sc. GEOLOGY
(2Year Programme)

COURSE CODE: SEAR21

HAND BOOK

Annamalai University

Department of Earth Sciences

M.Sc. Geology (Two Year) Programme

Programme Code: SEAR21

(For students admitted from the academic year 2019-2020)

1. Name of the Programme:

Annamalai University offers a two year M. Sc. Degree Programme (Semester Pattern) in **Geology** under choice based credit system (CBCS) with provision for a research project in the second year. The term 'credit' is used to describe the quantum of syllabus for various courses in terms of hours of study. Core courses are a set of compulsory courses required for each programme. The minimum credit requirement for two year Masters Programme in **Geology** is 93.

2. Eligibility for Admission:

A student who has passed the B.Sc. Degree examination with Geology as major subject and Mathematics, Physics, Botany, Zoology or any other science subject as two of the allied subjects of this University or an examination of any other University accepted by the Syndicate of Annamalai University as equivalent thereto are eligible for admission.

3. Duration of the programme:

The two year Programme for the degree of Master of Science in Geology shall consists of four semesters, two semesters in the first year and two semesters in the second year.

The academic year shall be divided into two semesters, the first being from July to November and the second from December to April. The University examinations (end semester examinations) in the first/third semester shall be conducted in November and the examinations (end semester examinations) in the second/fourth semester in May. A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

4. Course Features:

The programme consists of core courses (CC) and elective courses (EC) distributed among the four semester periods. The core courses include theory, practical and project work, seminar, project report and viva voce examination.

5. Grading System:

The term grading system indicates a 10-point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

6. Structure of the Programme:

The Masters Programme will consist of:

i. Core courses which are compulsory for all students.
ii. Elective courses which students can choose from amongst the courses offered by the other departments of the same faculty as well as by the departments of other faculties of the University or within the Department.
iii. Dissertation / Project Work / Practical training / Field work, which can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.

7. Attendance:

Every teaching faculty handling a course shall be responsible for the maintenance of attendance Register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit for the End-Semester Examination. The student has to repeat the semester in the next year.

8. Examinations:

The internal assessment for each course theory papers carries 25% marks and is based on two session tests and a variety of assessment tools such as seminar and assignment and that for practical examination carries 40% marks. The pattern of question paper will be decided by the respective department. The tests are compulsory.

For internal assessment, the break-up shall be as follows:

Theory	Internal Marks	Practical	Internal Marks
Test-I	15	Test-I	15
Test-II		Test-II	15
Seminar and Assignment	10	Record	10
Total	25	Total	40

There will be one End Semester Examination with 75% marks for theory and 60% for practical. The pattern of question paper for theory examination is common for the entire faculty and will be decided by the respective faculty.

9. Evaluation of dissertation:

The dissertation shall be evaluated as follows

Internal assessment by the Research supervisor	25%
Valuation of Dissertation	50%
Viva-Voce Examination	25%

10. Marks and Grading:

A student cannot repeat the assessment of Session Test-I and Session Test-II. However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the head of the Department.

A minimum of 50 % marks in each course is prescribed for a pass. A student has to secure 50% minimum in the end semester examination.

If a candidate who has not secured a minimum of 50% marks in a course shall be asked to reappear for the exam for that specific course.

The student can repeat the End Semester Examination when it is offered next in the subsequent Odd / Even Semesters.

11. Grading:

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme.

Marks	Grade Points	Letter Grade	Class
90 and above	10	S	Exemplary
85-89	9.0	D+++	Distinction
80-84	8.5	D++	Distinction
75-79	8.0	D+	Distinction
70-74	7.5	A+++	First Class
65-69	7.0	A++	First Class
60-64	6.5	A+	First Class
55-59	6.0	B	Second Class
50-54	5.5	C	Second Class
49 or Less		RA	Reappear

The successful candidates are classified as follows.

I – Class 60% marks and above in overall percentage of marks (OPM).

II – Class 50-59% marks in overall percentage of marks.

Candidates who obtain 75% and above but below 89% of marks (OPM) and above 90% (OPM) shall be deemed to have passed the examination in FIRST CLASS with Distinction and exemplary respectively provided he/she passes all the courses prescribed for the programme at the first appearance.

12. Course-Wise Letter Grades:

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA. A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

A letter grade RA in any course implies a failure in that course. The RA Grade once awarded stays in the grade card of the student and will not be deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

If a student secures RA grade in the Project Work / Field Work / Practical Work / Dissertation, he/she shall improve it and resubmit if it involves only rewriting by incorporating the clarifications as per the suggestions of the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

Annamalai University

Department of Earth Sciences

M.Sc. Geology (Two Year) Programme

Programme Code: SEAR21

Programme Structure

(For students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/ Week			Marks		
		L	P	C	CIA	ESE	Total
Semester-I							
19GEO101	Core 1: Structural geology, Geomorphology & Tectonics	4		4	25	75	100
19GEO102	Core 2: Mineralogy and Mineral Optics	4		4	25	75	100
19GEO103	Core 3:Indian Stratigraphy and Marine Geology	4		4	25	75	100
19GEOP104	Core 4: Practical I Structural Geology, Mineralogy and Mineral optics		12	6	40	60	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
				21			
Semester-II							
19GEO201	Core 5: Economic Geology, Mining Geology and Ore Genesis	4		4	25	75	100
19GEO202	Core 6: Coal and Petroleum Geology	4		4	25	75	100
19GEO203	Core 7: Remote Sensing and GIS	4		4	25	75	100
19GEOP204	Core 8: Practical II Economic Geology, Ore petrology and Remote Sensing & GIS and Survey		12	6	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
	Elective 3: Department Elective	3		3	25	75	100
				24			
Semester-III							
19GEO301	Core 9: Igneous and Metamorphic Petrology	4		4	25	75	100
19GEO302	Core 10: Sedimentology and Micropaleontology	4		4	25	75	100
19GEO303	Core 11: Atmospheric Sciences	4		4	25	75	100
19GEOP304	Core 12: Practical III Petrology, Sedimentology and Micropaleontology and Geological mapping report.		12	6	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Elective 5: Department Elective	3		3	25	75	100
				24			
Semester-IV							
19GEO401	Core 13: Geophysical Exploration	4		4	25	75	100
19GEO402	Core 14: Geological and Geochemical Exploration	4		4	25	75	100
19GEO403	Core 15: Hydrogeology and Engineering Geology	4		4	25	75	100
19GEOP404	Core 16: Practical IV Geophysics, Geochemistry, Hydrogeology and Engineering Geology. Mining industry visit report.		12	6	40	60	100
19GEOP405	Project work Dissertation Viva-voce		12	6		60 40	100
				24			
	Total Credits			**93**			

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

Elective Courses

Interdepartmental Electives (IDE)

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1.	19 SOSE 115.1	Soft Skills	**English**	3	0	3	25	75	100
2.	19 MATE 215.1	Discrete Mathematics	**Mathematics**	3	0	3	25	75	100
3.	19 MATE 215.2	Numerical Methods		3	0	3	25	75	100
4.	19 MATE 315.1	Differential Equations		3	0	3	25	75	100
5.	19 STSE 215.1	Statistical Methods	**Statistics**	3	0	3	25	75	100
6.	19 STSE 215.2	Mathematical Statistics		3	0	3	25	75	100
7.	19 STSE 315.1	Bio-Statistics		3	0	3	25	75	100
8.	19 PHYE 215.1	Classical Mechanics and Special Theory of Relativity	**Physics**	3	0	3	25	75	100
9.	19 PHYE 215.2	Physics of the Earth		3	0	3	25	75	100
10.	19 PHYE 315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11.	19 PHYE 315.2	Energy Physics		3	0	3	25	75	100
12.	19 CHEE 215.1	Applied Chemistry	**Chemistry**	3	0	3	25	75	100
13.	19 CHEE 315.1	Basic Chemistry		3	0	3	25	75	100
14.	19 CHEE 315.2	Instrumental Methods of Analysis		3	0	3	25	75	100
15.	19 BOTE 215.1	Plant Tissue Culture	**Botany**	3	0	3	25	75	100
16.	19 BOTE 215.2	Plant Science – I		3	0	3	25	75	100
17.	19 BOTE 315.1	Gardening and Horticulture		3	0	3	25	75	100
18.	19 BOTE 315.2	Plant Science – II		3	0	3	25	75	100
19.	19 ZOOE 215.1	Animal Culture Techniques	**Zoology**	3	0	3	25	75	100
20.	19 ZOOE 315.1	Environmental Science		3	0	3	25	75	100
21.	19 BIOE 215.1	Basic Biochemistry	**Biochemistry & Biotechnology**	3	0	3	25	75	100
22.	19 BIOE 215.2	Basic Biotechnology		3	0	3	25	75	100
23.	19 BIOE 315.1	Biochemical Techniques		3	0	3	25	75	100
24.	19 BIOE 315.2	Immunology		3	0	3	25	75	100
25.	19 MIBE 315.1	Microbiology	**Microbiology**	3	0	3	25	75	100
26.	19 CSCE 215.1	R Programming	**Computer & Information Science**	3	0	3	25	75	100

DEPARTMENT ELECTIVE COURSES (DE)

S. No.	Course Code	Course Title	Hours/ week		C	Marks		
			L	P		CIA	ESE	Total
1.	19GEOE205.1	Environmental geosciences and disaster management	3		3	25	75	100
2.	19GEOE205.2	Medical Geology	3		3	25	75	100
3.	19GEOE305.1	Instrumentation and Analytical Techniques	3		3	25	75	100
4.	19GEOE305.2	Environmental Isotopes in Groundwater hydrology	3		3	25	75	100

PROGRAMME OUTCOMES (POs)

PO1	The programme in Geology will provide in depth knowledge in the field of earth science to the students.
PO2	The students will be capable of appreciating the existence and exploration of natural resource system.
PO3	Makes the students fully competent to undertake any job in the field of Geology.
PO4	Promotes interest of the student to take up higher studies in field of earth sciences.
PO5	Students will be fully aware of the earth environment and responsible for the management of environment

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the programme, the student will be able to

PSO1	Gains complete knowledge about all fundamentals of Geoscience branches.
PSO2	Understand the basic concepts on the earth structures, tectonics, morphology.
PSO3	Understand the mineral structures, chemistry of minerals and their formation. Rocks types their origin, classification and importance.
PSO4	Gains the knowledge on the distribution of various metallic and non metallic ores, economic importance, their genesis, and their distribution.
PSO5	Understand the origin and occurrence of petroliferous and coaliferous basins of India.
PSO6	Capable of doing exploration for mineral resources using, geological, geophysical, geochemical and remote sensing techniques.
PSO7	Gains the knowledge on the atmosphere, climate and its impact on earth.

Learning Objective (LO):

- To learn about the methods of mapping, mechanical properties and deformation structures in rocks.
- To understand the concepts of earth tectonics, geomorphic principles, mechanism of plate movements and various theories of plate tectonics.

Unit-1

Mechanical properties of rocks- - elastic, plastic and rupture. Theory of stress and strain. Behavior of minerals and rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles. Geometry and analyses of brittle-ductile and ductile shear zones.

Unit-2

Structural analysis: Principles and elements of structural analysis of simple and complex structures – Microscopic to macroscopic scale. Petrofabric analysis: Field techniques-laboratory techniques and interpretation. Stereographic projection – equal area projection and structural analysis. Tectonites, their classification and geological significance.

Unit-3

Basic principles and Concept of Geomorphology, erosion cycles. Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition, Influence of climate on processes. Geomorphic processes and landforms – fluvial, glacial, eolian, coastal and Karst topography.

Unit-4

Earth's gravity and magnetic fields. Concept of Geoid and, spheroid; Theories of palaeomagnetism. Ice ages and their periodicity. Applications of geomorphology in mineral prospecting, civil engineering, hydrology, structure, lithology and environmental studies. Geomorphology of India.

Unit-5

Isostasy concepts: Airy's and Pratt's theories. Continental drift- Theories of continental drift. Plate tectonics – types of plate boundaries – characteristic features of acceretionary, conservative and destructive boundaries– Indian plate tectonics – configuration of Indian plate – mobile belts in peninsular India – Evolution of Himalaya and Himalayan tectonics.

Books for study:

1. Davies, F, 1999, Dynamic Earth, Cambridge University Press
2. Thornbury, W.S.1969, Principles of Geomorphology, Wiley Eastern, New Delhi
3. Dayal, P. 1990. A Text Book of Geomorphology, Shukla Book Depot, Patna
4. Moores.E and Twiss R.J, 1995, Tectonics, Freeman & company
5. Keary.P, and Vine.F.J, 1990, Global Tectonics, Blackwell
6. Soumyajit Mukherjee, (2019) Techtonics and Structural Geology – Indian Context. 1st ed. Springer Geology

Reference Books / Supplementary reading:

1. Robert R. Compton, 1962, John Wiley & Sons, Manual of field geology, INC, Newyork, London
2. Leopold, L.S. et.al.,1964, Fluvial processes in Geomorphology, Eurasia Publishing House, New Delhi
3. Fairbridge, R.W. 1968, Encyclopedia of Geomorphology, Reinhold Book Corporation
4. King, L.C. 1967, Morphology of the Earth, 2nd Ed. Oliver & Boyd, London
5. Dayal, P. 1990. A Text Book of Geomorphology, Shukla Book Depot, Patna

Course Outcomes

At the end of the course, the student will be able to

- Students will gain the knowledge over mechanical properties of rocks.

- Students will able to understand the petrofabric and structural analysis of rocks.
- Understand the concept of geomorphology, processes and landforms.
- Understand the application of geomorphology and theories of paleomagnetism.
- Students understand the concept of plate tectonics and theory.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓					✓	✓					
CO2			✓				✓	✓				
CO3			✓									
CO4							✓					
CO5							✓					

Semester-I **19GEO102: Mineralogy and Mineral Optics** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To Understand the Concepts in Mineralogy and Crystallography.
- Study of physical, chemical and optical properties of minerals.
- The classification of crystals into system and classes.
- To learn the techniques of X- diffraction pattern and their interpretation.

Unit-1
Transformation of minerals- polymorphism, polytypism and polysomatism, Solid solution and exsolution. Isomorphism, atomic substitution- exsolution-order, disorder relations- polymorphism, pseudomorphism. Fluorescence in minerals. Metamict stage- staining techniques and microchemical test.

Unit-2
Optic axes, optic axial angle measurements- optic orientation. Conoscopic characters of uniaxial and biaxial minerals. Dispersion in crystals- optic anomalies.

Unit-3
Rock and Ore forming minerals: Structure, P-T stabilities, paragenesis and mode of alteration of silicates, oxides, carbonates, phosphates, sulphates and halides.

Unit-4
Symmetry elements, translation, rotation, reflection, inversion, screw and glide-point groups and crystal classes. Derivation of 32 crystal classes based on Schoenflies notation,. Correspondence between Schoenflies and international notation. Bravies lattices and their derivation. An outline of space groups.

Unit-5
Basic Principles of X-ray diffraction. X- ray diffractometer. Bragg's law and its application. Powder methods-calculation of cell dimensions. Identification of minerals from X-ray diffractogram.

Books for study

1. Buerger, M.J.1956 Elements of Crystallography, Jophn Wiley and sons,
2. Dana, E.S.1935 A Text Book of Mineralogy, John Wiley & Sons,
3. Ernest, E.Walhstrom, 1960, Optional Crystallography, John Wiley & Sons,
4. Mitra, S. 1994, Fundamentals of Optical, Spectroscopic and X-ray Mineralogy, available at S.R.Technico Book House, Ashok Raj Path, Patna.
5. Aretas N. Ndimofor (2018) The fundamentals of Crystallography and Mineralogy. Spears Media Press.

Reference Books / Supplementary reading:

1. American mineralogist special volumes on Mineralogy.
2. Azaroff, L.V. & Buerger, M.J.1959, The powder method, , Mc Graw Hill Book Co.,
3. Babu, S.K. and D.K.Sinha, Practical Manual of Crystal Optics, CBS Publihsers & Distributors.

Course Outcomes

At the end of the course, the student will be able to

- Students will get insight into the mechanism & formation of minerals under different condition as their special features.
- Understand the optical properties of minerals.
- Understand the paragenesis of minerals.
- Gain knowledge on how X- rays are useful in mineralogy studies.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓		✓				✓				
CO2								✓				
CO3								✓				
CO4				✓							✓	

Semester-I **19GEO103: Indian Stratigraphy and Marine Geology** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To learn about the stratigraphy and the description of strata and their relationship to tectonics, climate, fossils.
- To Understand the Precambrian to recent and geological boundary problems and applications of stratigraphy.
- To gain knowledge on marine environments, morphology, processes, classification, and marine resources.

Unit-1

Methods of startigraphic correlation. Stratigraphic correlation of fossiliferous and unfossiliferous strata. Dharwar-Stratigraphy, Indian distribution and their economic importance- Cuddapah Basin structure and tectonics, Stratigraphy and economic importance; Vindhyan system, Stratigraphy, fossils, age and economic importance.

Unit-2

Cambrian to Carboniferous system, their distribution and chief fossils. Gondwana group- Structure, Sedimentation and fossils, Palaeogeography and economic importance. Triassic and Jurassic system of extra- peninsular region and Kutch, their stratigraphy, classification and faunal characteristics.

Unit-3

Deccan traps and their distribution, age and economic importance. Cretaceous system of Pondicherry and its stratigraphy, distribution and faunal characteristics, Palaeogeography of Cretaceous Period. Cretaceous-Tertiary transition in India. Siwaliks - their distribution, sedimentation, climate, fossil assemblages and correlation. Quaternary geology- Pleistocene-Holocene system- division and distribution. Glacial and interglacial periods - Igneous epochs in India.

Unit-4

Origin of ocean water- Physical and chemical properties of sea water- Morphology of oceans: Continental margins, continental shelf, Continental slope, rise, submarine canyon, ocean floor, Abyssal hills, sea mounts and trenches. Ocean circulation: Causes and characters, surface currents, deep water circulation. Ocean waves and tides. Shore and Shoreline processes - sediment types, character, movement and distribution.

Unit-5

Life in the ocean; major environmental domains, types of marine life. Marine resources: heavy minerals, petroleum hydrocarbons, gas hydrates, Mn-nodules, Phosphorite, L.St. Evaporites (Salt and gypsum). Marine pollution, Coastal zone management and conservation.

Books for study:

1. Krishnan, M.S. (1982), Geology of India and Burma, 6th Edition, CBS Publishers and distributors.
2. Ravindra Kumar, (1985), Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern Ltd, New Delhi.
3. Wadia, D.Tata (1975), Geology of India and Burma, McGraw Hill Pub. Co., 4th Ed.
4. Keith Stowe, (1979), Ocean science, John Wiley and Sons, Newyork.
5. Kennett, J.P. (1982), Marine Geology, Prentice Hall, Inc. New Jersey.
6. King, (1967), An Introduction to oceanography, Mc Graw Hill Book Co., New York.
7. Kuenen, Ph.H. (1950), John. John Wiley & Sons, Marine Geology.
8. Shepard, F.P. (1960), Submarine Geology, John Hopkins press.

Reference Books / Supplementary reading:

1. Bowen, D.C. (1978), Quaternary Geology, Pergamon press.
2. Detrich, G. (1963), General Oceanography, Interscience, London.
3. Gignox, M.(1960), Stratigraphic Geology, Paris.
4. Grabau, A.W., (1957), Principles of Stratigraphy, John Wiley and Sons, Newyork.
5. James, (1982), Deltas, Process of deposition and models for exploration, M.Colman,2nd Ed. International Human Resources Development Corporation, Boston.
6. Palivaal, B.S. (1998), The Indian Precambrian, Scientific Publishers, Jodhpur

Course Outcomes

At the end of the course, the student will be able to

- Students will acquire knowledge on distribution of rock types and their formation at different ages.
- Understanding the ocean morphology and formation along with mineral resources of marine environment are known.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1			✓	✓								
CO2								✓				

Semester-I **19GEOP104: Structural Geology, Mineralogy and Mineral Optics** **Credits: 6**
Hours: 12

Learning Objective (LO):

- To study structural analysis using stereographic projection.
- To be familiar with megascopic and microscopic identification of minerals.
- To gain knowledge on the various determinative optical mineralogical features.

Structural Geology:

Elementary structural analysis with use of stereographic methods

Mineralogy & Mineral Optics:

1. Megascopic identification of: Tourmaline, Topaz, Beryl, Zircon, Rutile, Apatite. Calcite, Gypsum. Metamorphic minerals: Garnet, Cordierite, Kyanite, Sillimanite, Andalusite, Sphene, Staurolite, Chondrodite.
2. Microscopic study of: Tourmaline, Topaz, Beryl, Zircon, Rutile, Apatite. Calcite, Gypsum.
3. Metamorphic minerals: Garnet, Cordierite, Kyanite, Sillimanite, Andalusite, Sphene, Staurolite, Chondrodite.
4. Calculation of molecular and structural formulae of some important minerals.
5. Determination of plagioclase orientation in thin section and its Anorthite content from extinction angle measurements.
6. Birefringence of minerals-using Berek compensator.
7. Pleochroic scheme
8. 2V by Mallards method,
9. Optic signs of uniaxial and biaxial minerals.
10. Stereographic projections of crystals of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic system. Calculation of axial ratios, miller indices of faces application of Weiss zone law, Tangent relationships, Napier's rule, law of anharmonic ratio and equation to normal.
11. Determination of cell dimensions and identification of minerals from X-Ray diffractogram.
12. Goniometric measurement of interfacial angles.

Course Outcomes

- The students will gain hands on training on the identification of mineral and its composition.
- Students will be able to determine the three dimensional & visualization of crystals.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1			✓					✓				
CO2								✓				

Learning Objective (LO):

- To know about the economic mineral processes and the distribution of metallic and non-metallic minerals deposits.
- To study the Ores and their genesis and to understand the various techniques in mining, mine environment and mineral economics.

Unit-1

Classification of mineral deposits. Brief account on Process of formation of mineral deposits. Controls and localization of mineral deposits. Metallogenic epochs and provinces. Geological thermometry.

Unit-2

Mineral economics: concept and scope. Peculiarities inherent in mineral industry. Strategic, critical and essential minerals – tenor, grade, cut-off grade, and industrial specification of minerals. National Mineral policies, taxation and mining legislation.

Unit-3

Role of Geologist in mining industries. Ore body investigation methods. Rock sampling methods. Ore reserve estimation techniques and UNFC. Introduction to mining. Classification of mining methods. Surface mining methods. Rock drilling types. Mine explosives. Bench parameters. Various mining machinery.

Unit-4

Terms associated with subsurface mining: shaft, adit, winze, raise, stope, drift, crosscut, gallery, ramp, mine support and ventilation. Underground mine layouts. Outline of underground coal mining methods. Organization and structure of mine. Preparation of mine plan, mining schemes. Environmental impact assessment (EIA) and environmental management plans (EMP), mine accidents and miners' diseases.

Unit-5

Principles of Ore microscopy and Ore microscope. Polishing and mounting of ores. Physical and optical properties of ore minerals. Ore textures and paragenesis. Micro chemical techniques and application of ore microscopy.

Books for study :

1. Aiyengar, N.K.N. (1964), Minerals of Madras, Dept. of Industries and Commerce, Madras.
2. Alan M. Bateman, (1961), Economic mineral deposits, Asia Publishing House.
3. Arogyaswami, R.N.P. (1970). Course in Mining Geology, Oxford and IBH Publishing house,
4. Deb, S. (1980), Industrial minerals and Rocks of India, Allied Publishers Pvt. Ltd.
5. Gokhale, K.V.G. K. and T.G. Rao, (1972), Ore deposits of India, Thompson press Ltd., Delhi – 6, India.
6. Krishnaswamy, S. (1972). India's mineral Resources, Oxford & IBH Publishing Co.,
7. Lindgren, W. (1933), Mineral deposits, Mc Graw Hill Book Co.

Reference Books / Supplementary reading:

1. Mc Kinstry, H.E. (1960). Mining Geology, Asia publishing house,
2. Sinha, R.K. and Sharma, B.N.L (1973). Mineral Economics, Oxford and IBH Publishing Co.,
3. William, C.Peters, (1989) Exploration and Mining Geology, John Wiley and sons, Second Ed.
4. Young, C.J. (1940). Elements of Mining, Mc Graw Hill Book co.,

Course Outcomes

- The students will gain the knowledge in the mineral and ore formation processes.
- They will have the knowledge on the methods & techniques in mining and also about the Mineral Economics concept.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓							✓				
CO2		✓							✓			

Semester-II **19GEO202: Coal and Petroleum Geology** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To gain knowledge about the hydrocarbon formation, varieties and distribution.
- To understand the different sedimentary basins of India and methods of exploration of petroleum.

Unit-1

Geological basis of coal formation. Physical and chemical properties of coal. Varieties and ranks of coal. Development of coal facies. Types of deposition and diagenesis of coal. Coalification and bituminization. Sampling of coal, Coal petrography.

Unit-2

Coal bed methane and gas hydrates. Prospecting and valuation of coal lands, Carbonization and gasification of coal,. Production of coal: export and import, conservation of coal. Distribution of Gondwana and Tertiary coal fields in India. Lignite deposits in India

Unit-3

Physical and Chemical properties of Petroleum. Origin of petroleum and natural gas. Characteristics of source rocks, reservoir rocks and traps. Migration and accumulation of oil and gas. Classification of petroliferous basins of India, detailed study of stratigraphic, structure and petroleum geology of Assam shelf, Cambay, Bombay, Krishna-Godavari and Cauvery Basins.

Unit-4

Introduction to drilling methods: types of drilling operations, designing of oil well. Down hole equipment: drilling rigs, its components and functions. Drilling fluids, well-heads, casing and cementing operations. Principles of kick control, fishing jobs. Drilling methods and equipment for directional, horizontal and multilateral wells. Types of offshore drilling rigs.

Unit-5

Duties of a well-site geologist. Geotechnical order. Mud logging. Fundamentals of Petrophysics. Archie's Formula- porosity, permeability, Preparation of composite logs. Principles of formation testing. Well completion, Enhanced oil recovery techniques. Gas hydrates and coal bed methane.

Books for study:

1. Gupta, P.K. and Nandi, P.K. (1995), Wellsite Geological Techniques and Formation Evaluation: A User's Manual, Vol. I, Oil and Natural Gas Corporation, Dehra Dun.
2. Levorson, A.L. Vakils, (1972), Geology of Petroleum, Peter and Simon Limited, Bombay,
3. Moore, E.S. (1980). Coal, John Wiley & Sons,
4. North, F.K. (1985), Petroleum Geology, Allen & Unwin, London.
5. Ross C.A, (1984), Geology of Coal, Narosa book distributors.
6. Selley, R.C. (1997), Elements of Petroleum Geology, 2nd Edition, Academic Press, London.

Reference Books / Supplementary reading:

1. Chilinger, G.V. and Vorabutr, P. (1981), Drilling and Drilling Fluids. Elsevier Science, Amsterdam.
2. Darling, T. (2005), Well Logging and Formation Evaluation, Elsevier Science, Amsterdam.
3. Ganju, P.N. (1955), Memoirs of the GSI Petrology of Indian coals, Vol.83.

4. Hyne, N.J. (2001), Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, 2nd edition, Pennwell Corporation, Tulsa, Oklahoma.
5. Serra, O. (1984), Fundamentals of Well Log Interpretation, Vol.1 and 2. Elsevier, Amsterdam.
6. Hunt J.M. (1996), Petroleum Geochemistry and Geology, 2nd Edition, W.H. Freeman, San Fransisco.

Course Outcomes

- The students will gain knowledge on the mechanism of formation of coal & petroleum.
- Understand the distribution of petroliferous and coaliferous basins of India.
- The students will know the technique of exploration of hydrocarbon resources.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		✓								✓		
CO2										✓		

Semester-II **19GEO203: Remote Sensing and GIS** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To know about the application of Remote sensing and photogeology in the interpretation of physiography, lithology and structures.
- To know the concepts of GIS & its application in geology.
- To become familiar with different GIS softwares and spatial data analysis, data base management system.

Unit-1

Principles - Stereoscopic depth perception, stereoscopy – concepts – viewing and measuring system – principle of floating mark – methods of parallax measurement – Vertical and Tilted photographs – geometry, scale, planimetric mapping. Remote Sensing - Electro Magnetic Spectrum. Stefan Boltzman law - Wiens-Displacement Law. Scanners – pushbroom and whishbroom – Panchromatic, multi spectral, hyperspectral scanners. Effects of Atmosphere, Energy interaction with surface features – Spectral reflectance of vegetation, soil and water. Earth resource satellites operating with optical sensors- Landsat, SPOT, IRS, WorldView

Unit-2

Fundamentals of Thermal Remote Sensing - Thermal radiation principles, thermal interaction behavior of terrain elements, thermal sensors and specifications. Interpretation of thermal image. Passive Microwave Remote Sensing - Introduction - History, antenna systems - Radiometry - Emission laws – interaction with earth features, applications. Active Microwave Remote Sensing - Radar basics - RADAR operation and measurements – SLAR - Imaging Geometry - Resolution Concepts, SAR – Concepts – Doppler principle, Interaction with Earth surface and vegetation.

Unit-3

Digital data – Introduction; Storage and Retrieval, Data Formats – BIP, BIL and BSQ. and GeoTIFF. Image rectification and restoration – Geometric correction – earth curvature and projection, satellite pass system and image warpening, skew corrections; Radiometric correction – Noise removal, sensor error, sun angle. Image enhancement – Contrast manipulation, level slicing, contrast stretching, Convolution, High and low pass Filtering. Information extraction – PCA, Ratio images, Classification – Supervised and unsupervised. Minimum distance to mean classifier, parallelepiped classifies, Guassian maximum likelihood classifier.

Concepts of rapid, static methods with GPS - pure Kinematic and Real time kinematic methods – basics of satellite geometry & accuracy measures – Mobile mapping

Unit-4

Definition of Map - Mapping Organsiation in India, Geographic Coordinates – UTM and UPS - Projection – Function - Types of Map Projections – Transformations – Function - Choice of Map Projection.
Geographic Phenomena and GIS concepts, Spatial and Non-spatial data – Definition of GIS – Components of GIS. Raster Data Model – Grid – Data Encoding – runlength encoding, Quadtree coding, Data Compression. Raster ordering – Row order, Row prime order, N order, Peano-Hibert. Vector Data Model – Spaghetti Structure, Whole Polygon Structure, Points and Polygons Structure, Topological Structure. Topological relationship between spatial objects. Raster Vs. Vector Comparison – File Formats for Raster and Vector. Web based GIS

Unit-5

Application in Natural Resource – Mineral exploration, groundwater prospect zone identification, suitable site for groundwater recharge. Mapping and monitoring of forest cover. Application in Disaster Management – Earth quake prone are zonation, Landslide prone area demarcation, delineation causes and mitigation of flood. Applications in Tsunami warning system and post tsunami damage assessment. Environmental satellite missions - NOAA, AVHRR, CZCS, Oceansat and Kalpana. Remote sensing and GIS in climatic changes - land degradation, desertification.

Books for study :

1. Burrough, P. A Principles of Geographical Information Systems for Land Resources Assessment, Clarandonr Press, Oxford, 1986.
2. Curran, P. Principles of Remote sensing, Longman, London, 1985
3. David J. Maguir, Micheal F Goodchild and David W Rhind (1991) GIS - Principle and applications, vol.I ans vol. II, John Willy and Sons Inc.New York, 1991.
4. Dent B.D,(1985) Principles of Thematic Map Design, addition- Wesley, Reading, Mass.
5. Drury, S. A. (1987), Image interpretation in Geology, Allen and Unwin. Drury, S. A. 1990, A guide to Remote sensing. Oxford Science Publication.
6. Gupta, R. P. (1991), Remote sensing geology, Springer- Verlag, Heidelberg.

Reference Books / Supplementary reading:

1. American Society of Photogrammetry, Manual of Remote Sensing, ASP Falls Church, Virginia, 2nd Volume, 1983.
2. Campbell, J, Introductory Cartography, Printers Hall Englewood Cliffs, N.J, 1984.
3. Amdahl G (2002) Disaster Response: GIS for public safety, Published by ESRI, Redlands California.
4. Freeman, H and Pieroni, GG, Map Data Processing, Academic Press, New York. 1980.

Course Outcomes

- The students will gain knowledge on the principle & application of remote sensing.
- They have the understanding on the techniques and details about various satellites & sensors.
- They will know the techniques of & interpretation and exposure to functional and application aspects of GIS.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		✓	✓					✓			✓	
CO2			✓					✓				
CO3											✓	

Learning Objective (LO):

- To understand how to identify the ores.
- To know the method of ore reserve estimation.
- To gain knowledge on the microscopic and megascopic properties of ore minerals.
- To learn Cartography, Remote sensing, GIS and digital image processing technique.
- To know the basics of engineering surveys.

ECONOMIC GEOLOGY & ORE PETROLOGY:

a. Preparation of polished ore specimens
b. Identification of ore minerals by reflected microscope
c. Interpretation of textures and paragenesis of ore minerals
d. Computation of ore reserves from sampling data
e. Estimation of ore reserves by traditional methods:
   included area method
   extended area method
   triangle method
   polygonal method
   cross section method.
f. Computation of ore reserves from maps

REMOTE SENSING & GIS:

I. Cartography, GPS and GIS

1. Cartography
   a. Contouring, Slope and Contour interval
   b. Morphometric analysis of drainage basin – Stream order and drainage density.
   c. Interpretation of topographical maps for relief features, settlement, vegetation
   d. Universal Transverse Mercator Projection
2. GPS
   a. Collection of way points and Tracks
   b. Downloading way points and Tracks
   c. Conversion of GPS data
   d. Mobile Mapping
3. GIS
   a. Data Encoding – Raster encoding, Run length encoding, Quad tree coding
   b. Exploring and Launch of Software
   c. Conversion of coordinates
   d. Geo-referencing
   e. Data creation and editing
   f. Scaling and Area determination
   g. Analysis

II. Aerial / Satellite Data and DIP

1. Aerial photo interpretation
   a. Annotations of Aerial Photographs
   b. Stereo vision test.

c. Eye base – photo base determination
d. Tracing details from stereogram and stereo pairs after basic interpretation.
e. Interpretations of Geology - lithology, Lineament, structural trend line mapping
f. Interpretations of Geomorphology – denudational, fluvial and volcanic landforms
g. Interpretations of land use / land cover and vegetation.

2. Satellite imagery interpretation
   a. Different satellite data products
   b. Marginal Information
   c. Geological Mapping – Igneous, Metamorphic and Sedimentary Rocks, Lineament Mapping, Structural Mapping.
   d. Geomorphological Mapping – denudational, fluvial and coastal geomorphology
   e. Water Resource – Surface water mapping, snow cover mapping, drainage pattern
   f. Interpretation of Thermal Scanner Imagery
3. Digital Image Processing
   a. Starting ERDAS imagine, and exploring the viewer interface
   b. Identifying image statistics, data format and Histogram
   c. Determination of Contrast Difference, Contrast Ratio and Image Quality
   d. Measuring Tools
   e. Band Combination
   f. Spatial Enhancement
   g. Supervised Classification

4. SURVEY (Civil Engineering Department)
   a. Chain, Plane table and principles
   b. Leveling by dumpy level-
   c. Principles of theodolite and microptic alidade
   d. Preparation of base maps by radial contouring and block contouring methods and marking of geological formation in them.

Course Outcomes

- Students can understand to identify the ores.
- The students will gain knowledge on ore reserve estimation.
- The students will know the field Map projection techniques using GPS.
- The student will interpret the GIS and GPS data.
- The students will gain knowledge on the survey techniques.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓	✓	✓			✓			✓			
CO2		✓									✓	
CO3						✓					✓	

Semester-III **19GEO301: Igneous and Metamorphic Petrology** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To understand the textures and structures of Igneous and Metamorphic rocks.
- To understand the various classification of igneous rocks.
- To understand the origin, paragenesis, classification and nature of igneous and metamorphic rocks.

Unit-1

Forms, textures and structures of igneous rocks and their petro-genetic significance. Classification of igneous rocks: mineralogical, chemical, C.I.P.W. Niggli and Streikeissen-UGS-Classification..

Unit-2

Petrography of igneous rocks- -Petrography and petrogenesis of Granites, Pegmatites, Alkaline rocks, Mono-mineralic rocks. Anorthosites and Dunites, Lamprophyres, Carbonatites, Charnockites and Ultra-mafics.

Unit-3

Diversity of igneous rocks. Reaction principle, magmatic crystallization, differentiation, assimilation. Petrographic province and variation diagrams. Plate tectonics and magmatic evolution. Trace elements in igneous rocks and their significance. Fluid inclusion studies of igneous rocks. Plate tectonics in relation to magma.

Unit-4

Metamorphic textures, structures and their significance. Grades, zones and facies of metamorphism. Goldschmidt's mineralogical phase rule and its application. Geothermometry and Geobarometry, Fluid inclusion studies in metamorphic rocks. Retrograde metamorphism, metamorphic differentiation, metasomatism, granitisation and migmatites. Metamorphism in relation to magma.

Unit-5

Application of geochronological methods-Sm/Nd, U/Pb method. Determination of age of metamorphic rocks. Plate tectonics in relation to metamorphism. Regional and contact metamorphism of pelitic and impure calcareous rocks. Paired metamorphic belts. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites and granitoids.

Books for study:

1. Anthony Hall, (1987), Igneous petrology, ELBS publishers.
2. Barkar, S. (1983), Igneous rocks, Daniel, Prentice Hall, Englewood Cliffs, New Jersey
3. Myron G.Best, (1982), Igneous and Metamorphic petrology, W.H.Freeman and Co., New York.
4. Phillipotts, A. (1992) Igneous and Metamorphic petrology, Prentice Hall.
5. Roger Mason, (1984), Petrology of the metamorphic rocks, CBS Pub. & Distributors.
6. Turner, F.J. & Verhoogen, J. (1960). Igneous and Metamorphic petrology, Mc Graw Hill Book Co.,
7. Tyrell, G.W. (1989), Principles of petrology, Methuren and Co., (Students ed.)
8. Wahlstrom, E.E. (1961). Theoretical Igneous petrology, John Wiley & Sons,
9. Winkler, H.G.S. (1979). Petrogenesis of Metamorphic rocks, Springer Verlag Vth Ed

Reference Books / Supplementary reading:

1. Barker, A.J.Chapman and Hill, (1989). Introduction to metamorphic textures and microstructures,
2. Barth, T.F.W. 919620. Theoretical petrology, John & Wiley and sons.
3. Bose, M.K. (1997), Igneous petrology, World Press.
4. Moorhouse, W.W. (1969), The study of rocks in thin sections, Harper and sons.
5. Turner, F.J. and Gilbert, C.M. (1954). Petrography H.Williams, W.H.Freeman and Co.,
6. Nockolds, S.R, Knox, R.W.O.B, Chinner, G.A. (1979), petrology for students, Cambridge University Press.
7. Paul, C.Hess, (1989), Origin of Igneous rocks, Harvard University press, Cambridge, London, England.

Course Outcomes

- To students will gain knowledge on the formation & types of Igneous and rocks.
- The students will know the rock classification and how to name.
- They will understand the influence of pressure and temperature influence on the formation of rocks.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓			✓			✓		✓	
CO2								✓			✓	
CO3			✓					✓				

Semester-III **19GEO302: Sedimentology and Micropaleontology** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To study the sedimentation processes at various environments.
- To understand sedimentary environments and facies.
- To understand microfossils and their classification.
- To understand the palynofossils and their importance.

Unit-1

Sedimentary processes- Sedimentary cycle-Weathering: Physical, chemical and biological. Definition, measurement, and interpretation of grain size. Lithification and diagenesis. Folk and Dunhalm classification. Physical properties of particles, porosity and permeability.

Unit-2

Introduction, Aqueous , Eolian and Glacial processes. Heavy mineral zones and their provenance. Paleocurrents and paleogeography and their significance.

Unit-3

Sedimentary environment- Sedimentary facies - Concept of sedimentary model- Walther's law. Sedimentary basins: Concept and classification: crustal sag, Arc-related and divergent plate boundary basins.

Unit-4

Introduction, Micropaleontological classification, sampling methods and sample processing techniques. Bathymetric distribution of microfossils. Morphological characters and palaeoecology of Foraminifera, Radiolarians, Diatoms and flagellates.

Unit-5

Palynofossils: Separation techniques, General morphology. Spores and pollens and their geological significance. Application of Micropaleontology in geological and petroleum exploration.

Books for study:

1. Folk, R.L. (1961). Petrology of Sedimentary rocks, Hemphills,
2. Kennet, J.P and Srinivasan; M.S, (1951). Foraminifera, W.H.Freeman & Co.,
3. Pettijohn, F.J, (1975). Sedimentary rocks, Harper & Bros. 3rd Ed.
4. Reineck, H.E., and Singh.J.P. (1980). Depositional sedimentary environments, Springer Verlag, New York.
5. Roy Lindholm, (1989), A Practical Approach to Sedimentology, Allen and Unwin, USA.
6. Sanders, G.M, (1978). Principles of Sedimentology, Friedman, E.J.John Wiley and sons, New York.
7. Richard C.Selly (1988) Applied Sedimentolgy- Acdemic Press, Harcourt Brace Jovanovic Publishers, London

Reference Books / Supplementary reading:

1. Galloway. W.C. and D.K.Hobdew, (1996). Terrigenous clastic sedimentary systems, Springer, Verlag, New York.
2. Gary Nichols, (1999). Sedimentology and Stratigraphy, Blackwell Science Ltd., London,

3. Twenhofel, W.H. (1950). Principles of sedimentation, Mc Graw Hill Book Co.,
4. Wilson, J.L, (1975). Carbonate facies in geological history, Springer Verlag, New York,
5. Bigot, G, (1985), Elements of micropaleontology, Grahm & Trotman, London.
6. John Collinson, Nigel Mounteny (2018) Sedimentary Structures. 4th ed. Dunedin Academic Press.
7. Rebecca Pettiford, (2018) Sedimentary Rocks.Jump Inc.

Course Outcomes

- The students will gain knowledge about process, formation of sediments.
- They know about the different sedimentary environments.
- They could identify the sediments relating to different geological environment and types of organism existed.
- They could understand about microfossils and their importance.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓			✓						
CO2			✓					✓	✓			
CO3												
CO4		✓			✓							✓

Semester-III **19GEO303: Atmospheric Sciences** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To understand the basic concept in atmospheric science.
- To understand atmospheric impact on climatic condition and weather pattern.
- Application of remote sensing on understanding the atmospheric science and in weather forecast.

Unit-1

Principles of Meteorology, origin and evolution of the Atmosphere, Structure of the Atmosphere – Composition, Thermal and Chemical. Composition of Atmosphere – Permanent gases, Trace constituents and Variable constituents. Earth Sun relationships – Equinoxes, solstices, perihelion and Aphelion, Causes of seasons. Radiation: Basic Laws - Rayleigh and Mie scattering, Multiple scattering. Seasonal and latitudinal variation of insolation. Emission and Absorption of Terrestrial Radiation, Radiation windows. Greenhouse effect, Tropical convection.

Unit-2

Cloud classification, Condensation Nuclei, Growth of Cloud drops and ice-crystals, Precipitation Mechanisms, Findeisen process, coalescence process - Precipitation of warm and mixed clouds, Artificial precipitation, type of precipitation, fog, Hail suppression. Basic equations and fundamental forces: Pressure, Gradient, Centripetal and Coriolis forces, Ekman spiral and transport, Langmuir circulation, scale analysis, geostrophic and gradient wind, Atmospheric turbulence, Continuity equation in Cartesian and Isobaric co-ordinates

Unit-3

General circulation and climate model – east west circulation in tropics – Climate variability and forcing; Low frequency variability, MJO Madden-Julian oscillation), ENSO, QBO (quasi-biennial oscillation) and Sunspot cycles. Basic principles of general circulation modeling, Ocean – atmosphere couple model, Grid-point and Spectral (GCMs). Role of the ocean in climate Modeling, Inter-annual variability of ocean fields and its Relationship with Monsoon.

Unit-4

Tropical Meteorology: Trade wind inversion, ITCZ, Cyclones – Tropical, extra tropical and anticyclones. Monsoon through tropical cyclones, SW and NE monsoons, Indian monsoon, jet stream, Western disturbances, and severe local convective systems in India. Withdrawal, Break active and Weak monsoons and their prediction. Air masses and fronts: Sources, Origin and Classification of Air masses, Fronts, frontogenesis, Parcel wind.

Unit-5

Concept of weather, climate and weather-climate differences, Climate Classification - Köppen's and Thornthwaite's. Climate change and Global warming. Indian climatology – four seasons. Meteorological Satellites – Polar orbiting and Geostationary Satellites, Visible and Infrared radiometers, Multiscanner radiometers; Identification of Synoptic systems, Fog and Sandstorms, Determination of Cyclones, Estimation of SST, Cloud Temperatures, Winds and Rainfall, Temperature and Humidity.

Books for study:

1. Bar Charts, (2012). Meteorology (Quick Study: Academic).
2. Donald Ahrens C, (2008), Meteorology Today: An Introduction to Weather, Climate, and the Environment. Study Guide/Workbook .
3. Frank R. Spellman , (2012). The Handbook of Meteorology.
4. Frederick K. Lutgens, Edward J. Tarbuck, Dennis Tasa , (2009) The Atmosphere: An Introduction to Meteorology (11th Edition).
5. Frederick K. Lutgens,, Edward J. Tarbuck, Dennis Tasa, (2012) The Atmosphere: An Introduction to Meteorology (12th Edition).
6. Steven A. Ackerman,Meteorology, John A. Knox, (2011) Third Edition.
7. Storm Dunlop, (2003). The Weather Identification Handbook: The Ultimate Guide for Weather Watchers.
8. Sverre Petterssen, (2008) Introduction to Meteorology.

Reference Books / Supplementary reading:

1. Donald Ahrens C, (2011) Essentials of Meteorology: An Invitation to the Atmosphere.
2. Donald Ahrens. C. (2008) Essentials of Meteorology.
3. James R. Holton, (2004). An Introduction to Dynamic Meteorology (International Geophysics).
4. Roland B. Stull, (1988). An Introduction to Boundary Layer Meteorology (Atmospheric Sciences Library).
5. Roland B. Stull, (1999). Meteorology for Scientists and Engineers.

Course Outcomes

- The students will gain the knowledge about the atmospheric science,
- They will understand the importance of the atmosphere and its role on the climatic condition and weather pattern.
- They will know about the application of remote sensing for weather forecasting

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓		✓							✓
CO2				✓	✓							✓

Learning Objective (LO):

- To study the megascopic and microscopic features of rocks and fossils.
- To Study the statistical techniques in analyzing grain size data.

PETROLOGY:

Preparation of thin sections of rocks - Megascopic and Microscopic identification - Texture, Structure and Petrogenesis.

Igneous Rocks:

1. Charnockite, Granite, Rhyolite and Dacite
2. Syenite, Nephlene Syenite, Trachyte, Diorite, Andesite
3. Anorthosite, Gabbro, Pyroxenite, Dunite, Basalt

Metamorphic Rocks:

4. Granitic gneiss, Hornblende Biotite Gneiss, Quartzite, Mica Schist, Ecologite

Sedimentary Rocks:

5. Conglomerate, Breccia, Sandstone, Arkose, Grit, Shale, Laterite, Limestone, Oolitic limestone.

SEDIMENTOLOGY:

Mechanical analysis of sediments. Statistical analyses of grain size data. Plotting of size analysis data. Determination of roundness and sphericity of grains. Separation of heavy minerals and study of their microscopic characteristics.

MICROPALEONTOLOGY:

Methods of separation of micro fossils. Identification of selected taxa of microfossil groups under the stereo binocular microscope and observation of morphological characters of some particular species. Benthic and Planktonic foraminifera – Interpretation of environmental significances.

Course Outcomes

- To students will get hands on training for preparation rock thin section.
- They will know the techniques of rocks and mineral identification.
- Students will able to interpret and identify the paleo-environmental condition of sediments.
- The students will able to analyze the electrical resistivity data, seismic data and geochemical data for exploration of minerals.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓	✓				✓				
CO2									✓			
CO3					✓							
CO4					✓						✓	

Semester-IV **19GEO401: Geophysical Explorations** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To know how geophysical principles and concepts
- To understand instruments used in the mineral exploration.
- To gain knowledge on the field conditions and interpretation of geophysical data.
- To know the different techniques in identifying the resources and the interpretation of geophysical data.

Unit-1

Scope and historical development of Geophysics- geophysical exploration methods- limitations- problem of ambiguity in geophysical interpretation Gravitational field of Earth. Measurement of gravity- types of gravimeter- Field Procedure. Reduction of gravity data-Interpretation of gravity anomalies and interpretation. Applications of gravity method in mineral exploration.

Unit-2

Electrical methods: Self potential method, Instruments, Field procedure. Resistivity method- Instruments, Field procedure, Interpretation. Electrical Resistivity Tomography concepts. Electromagnetic methods-Magneto-Telluric method -Induced Polarization Methods-Applications of electrical methods.

Unit-3

Earth's Magnetism and their concepts- Types of Magnetism, Magnetic measurements: Instruments-Field procedure- Corrections and reduction of data-Magnetic anomaly maps-Interpretation. Applications of magnetic methods in mineral exploration.

Unit-4

Elements of earthquake seismology; seismic waves, seismic sources, faulting source, Principles of reflection and refraction methods-Instruments and equipments-Operational methods-weathering and elevation corrections. Interpretation of a refraction seismic data by graphical and analytical techniques. Seismic reflection data processing.

Unit-5

Well logging principles and concepts. Open hole, cased hole and production logging; Electrical logs; lateral, latero, induction, S.P porosity logs. Principles of Radioactivity- sonic, density, neutron, natural gamma logging while drilling.

Books for study :

1. Brooks, A.R. (1972), Geobotany and Biogeochemistry in mineral exploration, Harper and Row.
2. D.A. Cox, (1995), The elements of Earth , Oxford University Press, New York
3. Dobrin, M.B. (1960), Introduction to Geophysical prospecting, , Mc Graw Hill Book Co., New Delhi.
4. Mathew N.O, Sadiku, 2007.Elements of Electromagnetics,., Fourth edition, Oxford University Press.
5. Mc Kinstry, H.E. (1960). Mining Geology, Asia publishing house, Course in Mining Geology.
6. Parasnis, D.S. (1975). Principles of Applied Geophysics, Chapman and Hall. Pacal, 2nd Ed. 1977.
7. Stanislane, M. (1984), Introduction to Applied Geophysics, Reidel Publishers. New York.

Reference Books / Supplementary reading:

1. Govett, G.J.S. (Ed) (1983). Handbook of Exploration Geochemistry, Elsevier
2. Hawkes, H.E. and Webb, (1965), Geochemistry in Mineral Exploration, Harper and Row Publishers.
3. Ramachandran Rao, M.B. (1975), Outlines of Geophysical prospecting (A Manual for Geologists) Prasa Ranga, University of Mysore,
4. Sharma, P.V. (1986), Geophysical methods in Geology, Elsevier
5. Stanislane, M. (1984), Introduction to Applied Geophysics, Reidel Publishers.
6. Telford.W.M, Sheriff, R.E., Gelot, L.P, (2001), Applied Geophysics (Second Edition) Cambridge University press. London.

Course Outcomes

- Students will gain knowledge over geophysical exploration techniques.
- Students will understand logging principles and concept.
- Exposed to analysis and interpretation of different geophysical data.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓				✓				✓	
CO2			✓								✓	
CO3							✓				✓	

Semester-IV **19GEO402: Geological and Geochemical Explorations** **Credits: 4**
Hours: 4

Learning Objective (LO):

- To know understand the principles and concepts of geological and geochemical explorations.
- To understand sampling and sample preparation methods.
- To gain knowledge on the field conditions and interpretation of geochemical data.

Unit-1

Reconnaissance Vs detailed mapping, surface mapping. Degree of precision, choice of scales, isolation of outcrops. Sampling: general principles. Methods of sampling: channel, chip, grab, pitting, trenching, digging. Sampling errors and precautions.

Unit-2

Mineralogical guides. Rock alteration: nature of alteration, target rings of mineral distribution. Stratigraphic and lithological guides, reasons for favorability, competent Vs incompetent formations. Fracture pattern as guides: (Structural guides) vein patterns. Contacts and folds as guides: folds younger than the ore; folds older than ore; dislocated ore bodies. Physiography in relation to oxidation and enrichment. Residual ores, supergene sulphide zones

Unit-3

Geochemistry, Introduction, definition, aim and scope. Origin and abundance of elements. Distribution of elements in lithosphere. Geochemical cycle-Geochemical classification of elements. Geochemical differentiation of elements in exogenic and endogenic cycle. Redox reactions and Eh-pH diagrams and their applications.

Unit-4

Geochemical Exploration: Introduction, Principles of geochemical exploration, geochemical environment. Study of geochemical dispersion, mobility, geochemical association. Methods of surveying and sampling: Anomalies, background value, threshold value, path finder elements.

Unit-5

Methods of geochemical exploration: (a) Lithogeochemical prospecting (b) Hydrogeochemical prospecting (c) Biogeochemical prospecting (d) Geobotanical prospecting. Anomalies in Residual overburden. Leached ore outcrops, Gossans and Residual soils transported overburden. Geochemical anomaly map and interpretation of data. Geochemical trace element indicators and their significance.

Books for study:

1. Fyfe, W.S.1964, Geochemistry of solids. Mc Graw Hill Book Co.,
2. Goldschmidt, V.M.1954, Geochemistry, Oxford University press.

3. Krauskopf..K.B , 1986, Introduction to geochemistry, , Mc Graw Hill.
4. Mason, B.1971, Principles of Geochemistry, John Wiley & Sons.
5. Mason,B. and Moore.C.B. 1991, Introduction to Geochemistry, Wiley Eastern
6. Rankama and Sahama, (1950), Geochemistry, University of Chickago Press,
7. Misra K.C. (2005) Introduction To Geochemistry: Principles And Applications. Wiley India.
8. William M. White(2013)Geochemistry. Wiley-Blackwell.

Reference Books / Supplementary reading:

1. H.E. Hawkes, J.S. Webb. 1979. Geochemistry in Mineral Exploration,: Academic Press, London
2. Jenners, 1987. Geochemical exploration, Universal Books Distributors Co.,
3. Kovalevskii, A.L. 1979, Biogeochemical exploration for mineral deposits, Oxonian press.
4. Arthur Brownlow 1982, Geochemistry, Prentice Hall

Course Outcomes

- Students will gain knowledge over geochemical survey techniques.
- Students will understand sampling principles.
- Students will understand various guides for geochemical explorations.
- Understand the various geochemical element distributions.
- Understand the various geochemical exploration techniques.
- Exposed to analysis and interpretation of different geochemical data.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓					✓			✓	✓	✓	
CO2		✓									✓	
CO3		✓	✓									
CO4				✓								
CO5					✓						✓	✓
CO6												

Learning Objective (LO):

- To know and understand about the distribution and threat to water resources.
- To Understand the relationship of water to rock properties and water qualities.
- To know the techniques for finding ground water resource its exploration and artificial recharge methods.
- To know about the engineering properties of rocks and geological importance in major engineering projects.

Unit-1

Theory of groundwater flow; Darcy's law and its applications; Determination of permeability in laboratory and in field; Flow through aquifers; steady, unsteady and radial flow conditions; Evaluation of aquifer parameters of confined, semi-confined and unconfined aquifers -Thiem, Thies, Jacob and Walton's methods, Groundwater modeling. Groundwater provinces of India

Unit-2

Types of water wells and methods of construction; Design, development, maintenance and revitalization of wells; Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data; Groundwater contamination; natural and anthropogenic.

Unit-3

Groundwater problems related over-exploitation and groundwater mining; Groundwater problems in urban areas; Saline water intrusion; Rainwater harvesting and aquifer recharge methods; Conjunctive use of surface and groundwater; Groundwater legislation in India.

Unit-4

Role of geology in Engineering projects: Engineering properties of rocks. Choice of rocks as constructional, road metals and their distribution in India, Nature and properties of building stones. Seismic zones and designing structures. Soil mechanics. Stability of slopes.

Unit-5

Geological considerations in the construction of tunnels, dams, bridges, roads and reservoirs. Dams classification and parts of dams. Systematic dam site investigation. Geological, geomorphologic and geophysical investigations for foundation studies. Water fitness of reservoirs and, failure of dams. Important river valley projects of India. Tunnels: types, systematic investigations of sites and problems in the construction of tunnels.

Books for study:

1. Davie and De Weist, (1965), Hydrology, John Wiley and Sons.
2. Karanth, K.R. (1998), Groundwater Management, S.R.Technico Book house, Ashok Raj path, patna-6.
3. Legget, H.F. (1962). Geology and Engineering, Mc Graw Hill Book co.
4. Ragunath, H.M. (1983). Ground water, John wiley & sons,
5. Subramanya, K. (1994). Engineering Hydrology, Tata Mc Graw Hill.
6. Todd, D.K. (1980).Groundwater Hydrology, John Wiley and Sons, 2nd Ed.

Reference Books / Supplementary reading:

1. Geohydrology, Rogar, J.M.Deweist, (1965), John Wiley and sons.
2. Howrman Bower, (1965), Ground water Hydrology, Mc Graw Hill Book Co.
3. Krynine, D.P. and Judd, W.R. (1957), Principles of Engineering and Geotechniques, Mc Graw Hill Book co.
4. Rogar, J.M. Deweist, (1965), Geohydrology John wiley and sons,
5. Tolman, C.P. (1998), Ground water, Mc Graw Hill Book Co.
6. Zaruba, Q. and Menci, V. (1976). Engineering Geology, Elsevier Scientific Publishing Co.,

Course Outcomes

- Students will gain knowledge on the types & mechanism of movement of groundwater.
- Students will know on the criteria for construction of wells and water quality standards.
- The students will get an exposure to the method of site selection for construction major engineering structures.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓										✓	
CO2		✓	✓				✓					✓
CO3												✓

Semester-IV **19GEOP404: Practical – IV Geophysics, Geochemistry, Hydrogeology and Engineering Geology** **Credits: 6 Hours: 12**

Learning Objective (LO):

- To have an exposure to analyze and interpret different geophysical and geochemical data
- Aimed to familiarize the with the water quality analysis.
- Water resource potential estimation.
- To understand the application of geology in civil engineering project.

GEOPHYSICS:

- Geophysical methods-Gravity, Magnetic, Seismic methods problems and applications. Preparation of geophysical anomaly maps, Isoresistivity maps.
- Electrical Resistivity field survey and data analysis (resist soft ware & IB2 win)
- Interpretation of Sp and electrical logging techniques.

GEOCHEMISTRY:

- Preparation of geochemical anomaly maps and interpretation based on statistical analysis of data. Determination of background threshold values from maps.
- Calculation of C.I.P.W. Norm, Niggli values, Variation diagrams of Harker and Niggli. ACF, AKF diagrams.

HYDROGEOLOGY:

i. Calculation of Rainfall by Arithmetric method.
ii. Determination of catchment area by Theissen polygon method and calculation of rainfall
iii. Determination of catchment area by Isohyetal method and calculation of rainfall
iv. Determination of catchment area by Geometric method and calculation of rainfall.
v. Basin wise Groundwater Budgeting.
vi. Calculation of Specific yield and transmissibility from the given data
vii. Interpretation of well inventory data from pump test data
viii. Interpretation of water well logs.
ix. Identification of groundwater zones from resistivity data.
x. Chemical analysis of major dissolved constituent of groundwater by titrimetric method
xi. Chemical analysis of major dissolved constituent of groundwater by spectrophotometric method
xii. Chemical analysis of major dissolved constituent of groundwater by flame photometric method.
xiii. Determination and calculation of Water quality parameters pH, EC, TDS.
xiv. Calculation of SAR, TH, NCH, TDS, EC and interpretation for various uses

ENGINEERING GEOLOGY:

i. Engineering properties of different geological materials.
ii. Selection of suitable places for construction of dams from the map.
iii. Selection of suitable places for the construction of tunnels from the map.
iv. Selection of suitable places for the construction of reservoirs from the map.
v. Selection of suitable places for the construction of ghat roads from the map.

Course Outcomes

- Gain training on the chemical analysis of water.
- They will be able to make the estimation of water resource potential.
- They will be trained for the criteria for the selection of suitable sites for engineering structures.

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓										✓	
CO2		✓									✓	
CO3			✓									✓

Semester-IV **19GEOP405: Project Work Dissertation & Viva-Voce** **Credits: 6**
Hours: 12

Learning Objective (LO):

- Each student will undergo a practical internship training programme in reputed geological organizations for two to three weeks.
- Students will individually select a topic under a guide in the faculty and submit a dissertation for evaluation.

Course Outcomes

- Students will get hands on training in the reputed organization related to their subject.
- Students will get trained in a specific field of specialization.
- Students will have the practice of writing a project report

COURSE CODE: 19 GEOE 205.1
Course Title: ENVIRONMENTAL GEOSCIENCES & DISASTER MANAGEMENT

Semester- II **Credits: 3**
Hours : 3

Learning Objective (LO):

- To understand the principles of environmental geology..
- To know the types of Environmental hazards & disasters.
- To know about the emerging approaches in Disaster Reduction & Management.

UNIT-1

Principles of environmental geology-ecological perspective-problems of environment- global and Indian perspective. Environmental degradation, Components of environment-their interaction and related problems.

UNIT-2

Geohazards –Natural and Man made- Endogenic: Tectonism, Volcanoes, Earthquakes, landslides and Exogenic: cumulative atmospheric hazards, cyclones, lighting, hailstorms, drought, cold waves, heat waves and floods.

Unit-3

Environmental Pollution - definition, causes and concepts, sources of pollution-nature of pollutants-Concept of acid rain, greenhouse effect, Ozone depletion. Deforestation and erosion, global warming and climatic change concepts. Causes and prevention of - Air pollution, water pollution, soil/land pollution,

marine pollution, nuclear hazards. Solid waste management: causes, effect and control, urban & industrial waste.

Unit-4

Environmental impacts due to mining and mineral processing. Wasteland reclamation. Indian environmental laws related to water, air and forest conservation. Environmental Impact Assessment (EIA). Environmental Management Plan (EMP). Concepts and components of Environmental Auditing. Environmental Ethics. Environmental Education.

Unit-5

Introduction, Theoretical concepts and developments of disaster management. The role of coordination in disaster management, Different approach to disaster recovery. Planning, Prevention and preparedness. The essential strategic planning for emergency management for natural and manmade hazards. The role of disaster mitigation institution- Meteorology, seismological, volcanology, hydrology, industrial safety inspectorate- institution of urban and regional planners, awareness conservation movement, education and training of disaster, role of media.

Books for study:

1. Harsh .K. Gupta (2003), Disaster Management, University Press
2. Ignacimuthu.S, 1998, Environmental Awareness and Protection, Phoenix Publishing House Pvt. Ltd., New Delhi
3. R.B Singh(Ed) (2000) Disaster Management, Rawat Publication, New Delhi.
4. Upendra Kumar Sinha, 1986, Ganga-Pollution & Health Hazard Inter-India publication, New Delhi.
5. Sharma.R.K., Gagandeep shrma (2016) Natural Disaster APH Publications
6. Vaidyanathan.S (2011) An introduction to disaster management. IKON books.

Reference Books / Supplementary reading:

1. Keller.E.A, 1978, Environmental Geology, A. Charles E.Merrill Pub. Co., A. Bell & Howell Co., London, 4th Ed.
2. Lawrence Lundgren, 1986, Environmental Geology, Prentice-Hall.
3. Strahler.A.N and Strahler.A.N, A.H.,1973, Environmental Geosciences, Wiley International Edition.
4. Thomas D. Schneid and Larry Collins (2001), Disaster management and preparedness: Occupational safety and health guide series, CRC Press
5. Valdiya, K.S., 1987, Environmental Geology, Indian context, Tata Mc Graw Hill. Bombay.

Course Outcomes

- The students will gain knowledge on the interaction between the human activities and the atmosphere, ocean and the solid Earth.
- Understand the different environmental pollution, its causes and remedies.
- They will gain the knowledge of the disaster management plan and methods.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1												✓
CO2			✓		✓							
CO3					✓							✓

Semester-II **19GEOE205.2: MEDICAL GEOLOGY** **Credits: 3**
Hours: 3

Learning Objective (LO):

- To understand different geological environment.
- To understand the fundamentals of medical geology.
- To understand various hazardous parameters on the earth.
- To understand the causes to human by various elements.

Unit-1

General characteristics of tropical, subtropical environments, arid zone, seasonally dry tropics and sub-tropics, humid tropics, and sub-tropics zone and mountainous zone.

Unit-2

Medical Geology- Perspectives and Prospects, Public Health and Geological Processes: An Overview of a Fundamental Relationship. Environmental Biology-Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements on Chemical and Biological Perspective and its functions.

Unit-3

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 in India, source, nature, cause and extent. Water 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. 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.

Unit-5

Environmental Toxicology, Environmental Epidemiology, Environmental Medicine, Environmental Pathology, Speciation of Trace Elements. Mineralogy of Bones, Inorganic and Organic Geochemistry Techniques, Histochemical and Microprobe Analysis in Medical Geology.

Books for study:

1. C.B. Dissanayake and R.Chandrajith (2009). Introduction to Medical Geology, Springer, London
2. H.Catherine, W.Skinner, Antony R. Berger(2003). Geology and Health: Closing gap, Oxford Univ. press, New York.
3. K.S. Valdiya (2004). Geology, environment, Society, University press(India), Hyderabad.
4. Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas (2009). Heavy Metals in the Environment , CRS Press, Taylor & Francis Group, Boca Raton, FL
5. M.M. Komatica, (2004) Medical Geology, Vol.2, Effects of geological environment on Human health, Elsevier, U.K.
6. Oile Selinus, B. Elsevier(2003). Essentials of Medical Geology (2005), Acemedica Press., U.K.

Reference Books / Supplementary reading:

1. Iosif F.Volfson (2010). Medical Geology: Current Status and Perspectives, 2010. Russian Geological Society (ROSGEO) Publisher. Moscow.
2. Scott S. Olson, (1999) International Environmental Standards Handbook , CRC Press, London.
3. William N.Rom, (2012). Environmental Policy and Public Health - Air Pollution, Global Climate Change, and Wilderness, by John Wiley & Sons, Inc. Published by Jossey-Bass A Wiley Imprint.

4. Oile Selinus, B. Finkleman, R.B., A.Jose (2010) Medical Geology- Regional synthesis(2010), Springer, London

Course Outcomes

- Students will gain knowledge on geology and medicine.
- Students will understand various elemental concentrations on the earth.
- Exposed to health effects of fluoride, iodine and nitrate and their effects on human health.
- Understand the environmental toxicology, speciation of trace elements and effects.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓					✓						
CO2			✓									
CO3				✓					✓			
CO4												✓

Semester-III **19GEOE305.1: Instrumentation and Analytical Techniques** **Credits: 3**
Hours: 3

Learning Objective (LO):

- To Focus on instrumentation and analytical techniques for various geological applications.
- To know about the different geological techniques for sample analysis.
- To understand the analytical techniques using various instruments.

Unit-1

Rock sample collection, sediment sample collection, water sample collection, samples for geochemical study. Collection of samples from exposed materials. Sampling apparatus-Scraper or drag bucket type of sampler, coring tube samplers, Snapper or grab bucket samplers, Rod samplers.

Unit-2

Sample preparation for thin section of hard rocks and sediments. Preparation of Polished ore section Petrographic study of thin sections. Sample etching, staining and modal count techniques. Techniques of photomicrography. Thin section preparation of heavy minerals.

Unit-3

Separation; panning- rolling, sieving and hand picking. Separation of minerals-Magnetic separation-Dielectric separation of mineral particles. Electrostatic Separation.

Unit-4

Determination of major and minor elements. Principles of geological application of cathodoluminiscence, Flame photometer, Spectrophotometer, atomic absorption spectrophotometry, inductively coupled plasma-atomic emission spectrometry.

Unit-5

X-ray fluorescence spectrometry, Scanning and Transmission electron microscopy, Micro probe analysis. X-ray diffractometry, Principles of Chromatograph.

Books for study:

1. Galen.W.Ewing, 1975, Instrumental methods of chemical analysis, , 4th Ed. International student Ed. Mc Graw Hill, Book Co.,
2. Manual of Mineralogy, John Wiley, Klein, C and Hurlbut,Jr. C.S. John Wiley, 1983.
3. Sharma, B.K.1998, Instrumental methods of chemical analysis, GOEL, Publishing House, Meerus.
4. Spear,F.S,1993, Mineralogical phase Equilibria and pressure-Temperature-Time paths. . Mineralogical Society of America Pub

Reference Books / Supplementary reading:

1. Phillips, W.M.R. and Griffen, D.T. . 1986, Optical Mineralogy, CBS EdLaboratory Handbook of Hutchinson, C.S. , 1974, Petrographic techniques, John Wiley,
2. Putnis, Andrew, 1992, Introduction to Mineral Sciences, , Cambride University press,
3. Deer, W.A., Howie, R.A., and Nuclear structure, atomic weights, Zussman. 1996.The Rock forming minerals, Longman, London.

Course Outcomes

- Gain knowledge on the application, advanced instruments to be used for analysis of water, rocks & minerals.
- Students gain knowledge on the preparation of samples for different analysis.
- Students understand the principles of various instruments for the study of geological samples.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓		✓			✓						
CO2											✓	
CO3			✓								✓	✓

Semester-III | **19GEOE305.2: Environmental Isotopes In Groundwater Hydrology** | **Credits: 3** **Hours: 3**

Learning Objective (LO):

- To know the characterization of isotopes.
- To understand the fractionation and measuring techniques.
- To understand the application of isotopes in Geology.
- Environmental applications of isotopes with reference to specific problems in groundwater exploration.

Unit-1

Origin, characteristics, natural abundance and applications of Boron, Nitrogen, Silicon, Sulphur, Chlorine, Uranium series.

Unit-2

Water Sampling and Treatment - Water sampling and storage - Laboratory treatment of water samples Mass spectrometry - Final definitions. Instrumental uncertainties - Statistical uncertainties - Error propagation - Least-squares fit - Chi-square test

Unit-3

Relation between $^{18}O/^{16}O$ and $^{2}H/^{1}H$ in natural waters –Evaporation, Clouds and Precipitation - marine and continental atmosphere. Tritium in the atmosphere - Characteristics of tritium - Atmospheric CO_2 concentrations - Stable carbon isotopes in atmospheric CO_2 - Stable oxygen isotopes in atmospheric CO_2 - Radiocarbon in atmospheric CO_2.

Unit-4

Types of tracers - Types of tracer experiments – Isotopic tracers. Water Rock Interaction - physical absorption - Chemical absorption - Exchange of ions - Chemical interaction between solutes.

Unit-5

The radiocarbon dating - ^{14}C standard - natural ^{14}C variations - ^{14}C age determination - Palaeoclimate reconstruction. Groundwater salinization in coastal aquifers.

Books for study:

1. Clark, I and Fritz, P (1997) “Environmental isotopes in hydrogeology”. Lewis Publishers, Boca Raton.
2. Mazor, E. (1997) “Chemical and isotopic hydrology. The applied approach”. Maecel-Dekker Inc, New York, USA.
3. Environmental Isotopes in the Hydrological Cycle - Principles and Applications. Volume I Introduction: Theory, Methods, Review, IAEA/UNESCO, VIENNA

Reference Books / Supplementary reading:

1. Environmental Isotopes in the Hydrological Cycle - Principles and Applications. Volume II Atmospheric Water, IAEA/UNESCO, VIENNA
2. Environmental Isotopes in the Hydrological Cycle - Principles and Applications. Volume VI Modeling, IAEA/UNESCO, VIENNA

Course Outcomes

- Understand the different isotopes and their distribution.
- Gain knowledge on the water treatment.
- Understand the distribution of important isotopes in the atmosphere.
- Gain knowledge on the tracers.
- Understand the dating and age determination using isotopes.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓					✓						✓
CO2								✓				
CO3						✓						
CO4	✓					✓						
CO5	✓					✓						

Semester-II **19GEOE215.1: Environmental Geosciences** **Credits: 3**
Hours: 3

Learning Objective (LO):

- Aim to study the various components of Atmosphere.
- To Understand the energy sources.
- To understand the various natural and Manmade Hazards.
- To understand the water and air qualities and its issues.
- To understand the environmental management policies.

Unit-1

Components of Environment, Atmosphere, hydrosphere, lithosphere, biosphere, their interactions and related problems. renewable and nonrenewable resources- types of alternative renewable energy sources-their advantages.

Unit-2

Natural hazards. Tectonism, Volcanoes, Earthquakes, landslides and floods. Coastal hazards. Manmade environmental hazards: Mining activity, Man’s influence on earth’s energy balance.

Unit-3

Pollution. Concept and definition., concept of acid rain, greenhouse effect, Ozone depletion. Water pollution-drinking water quality standards, pollution, Industrial discharge, municipal sewage discharge, agriculture run off. Types of pollutants: Organic and inorganic and their fate in the environment.

Unit-4

Air pollution-Ambient Air quality standards-Pollution due to burning of fossil fuels, Various particle collection devices, odour abatement, Fuel gas desulphurization. Deforestation and erosion, global warming and climatic change concepts.

Unit-5

Environment legislation, International environmental agreements, Indian Environmental laws. Environment Impact Assessment techniques (EIA). Environmental management plan (EMP), concepts and components of environmental auditing. Environmental Gradients. Tolerance and Adaptation. Environmental education.

Books for study:

1. Arunkumar, (1999). Environmental Problems, Anmol Publications, New Delhi, Vol. I & II.
2. Charles, A. (1979), Environmental Geology, Edward Keller, E.Merrill Pub. Co., A. Bell & Howell Co., London, 4th Ed.
3. Corbitt, R.A., (1990), Standard Handbook of Environmental Engineering, Mc Graw Hill, Newyork.
4. Dey, A.K. (1997) Environmental Chemistry, New age International Publishers, Mumbai.
5. Flagen. R.C. and Seinfeld, J.H. (1988), Fundamentals of Air pollution control, Prentice-Hall, Englewood, Cliffs, New Jersey.
6. Valdiya, K.S. (1987), Environmental Geology, Tata Mc Graw Hill.

Reference Books / Supplementary reading:

1. Metleaf and Eddy, (1991), Wastewater Engineering Treatment, Disposal Rouse 3rd Ed., Mc Graw Hill, New York.
2. Roy Brewer, (1964) Fabric and Mineral analysis of soils, John Wiley & Sons, New York.
3. Strahler, A.N. and Strahler, A.N. (1973). Environmental Geosciences, Hamilton Publishing Co., California.
4. Upendra Kumar Sinha, (1986), Ganga -Pollution & Health Hazard by Inter-India publication, New Delhi.

Course Outcomes

- The students will gain knowledge on the interaction between the human activities and the atmosphere, ocean and the solid Earth.
- Understand the different environmental pollution, its causes and remedies.
- They will gain the knowledge of the disaster management plan and methods.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓				✓	✓						
CO2					✓							✓
CO3					✓							

Semester-III | **19GEOE315.1: Applied Geophysics** | **Credits: 3** **Hours: 3**

Learning Objective (LO):

- Illustrating the new frontiers of geosciences as a tool for various exploration.
- To understand the basic principles of geophysical explorations.
- To understand the basic methods of geophysical explorations.
- To understand the radioactive and earth's magnetic field for exploration.

Unit-1

The earth and the solar system-important basic physical and chemical properties of the planet earth. Description and identification of important rock forming minerals-Physical & Optical. Description and identification of important rock types.

Unit-2

Seismology-Basic principles. Earthquakes - observational magnitude and intensity scales-Seismic wave-types. Seismological instruments and observations. Principle of seismic method of prospecting-seismic reflection-seismic refraction Oil resource exploration.

Unit-3

Electrical method- Principles-Self potential method (SP method)-Resistivity method-electromagnetic method (IP-method) instruments-interpretation of resistivity data. Exploration of Groundwater and mineral deposits.

Unit-4

Gravity methods-Principles and application of gravity method. Radioactivity-Principles, applications and instruments-Exploration of radioactive minerals.

Unit-5

Magnetic methods – Principles and applications of magnetic method. Principles of Palaeonmagnetism – Geomagnetic fields.

Books for study:

1. M.B.Dobrin, (1976), Introduction to Geophysical Prospecting, McGraw Hill Book Co., New York.
2. M.B.Ramachandra Rao, (l987) outlines of Geophysical Prospecting. A Manual for geophysics Educational Pvt. Limited. Dehradun, India.
3. Rock Magnetism. (l961) Takesi Nagata, Plenuim press, New- York.
4. Fowler, (1990). The Solid Earth: An introduction to Global Geophysics. C.M.R. Cambridge University press.

Reference Books / Supplementary reading:

1. Govett, G.J.S. (Ed) (1983). Handbook of Exploration Geochemistry, Elsevier
2. Hawkes, H.E. and Webb, (1965), Geochemistry in Mineral Exploration, Harper and Row Publishers.
3. Sharma, P.V. (1986), Geophysical methods in Geology, Elsevier

Course Outcomes

- Students will gain knowledge over geophysical exploration techniques.
- Students will understand logging principles and concept.
- Exposed to analysis and interpretation of different geophysical data.

Outcome Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	✓					✓						
CO2		✓									✓	✓
CO3			✓								✓	