ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF EARTH SCIENCES

M. Sc. GEOLOGY
(5 Year Programme)

PROGRAMME CODE: SEAR 51

HAND BOOK

Annamalai University

Department of Earth Sciences

M.Sc. Geology (Five Year Integrated) Programme

Programme Code: SEAR51

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

1. Name of the Programme:

Annamalai University offers a five year M. Sc. Degree Programme (Semester Pattern) in **Geology** under choice based credit system (CBCS) with provision for a research project in the fifth year. The term 'credit' is used to describe the quantum of syllabus for various programmes in terms of hours of study. Core courses are a set of compulsory courses required for each programme. The minimum credit requirement for five year Masters Programme in **Geology** is **237**.

2. Eligibility :

Candidates for admission to the First year of the 5-Year Integrated M.Sc. Geology Degree Programme shall be required to have passed in higher Secondary Course examinations (HSC) (10+2 level) or equivalent thereto under academic stream in any science group.

3. Semesters:

An academic year is divided into two semesters, Odd semester and Even semester. The normal semester periods are:

Odd semester: July to November (90 working days)

Even semester: December to April (90 working days)

4. Credit:

The term credit is used to describe the quantum of syllabus for various courses in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.

5. Courses:

A course carrying one credit for lectures, will have instruction of one period per week during the semester, if four hours of lecture is necessary in each week for that course then 4 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lecture tutorials/laboratory work and other form of learning in a 15 week schedule:

i) One credit for each lecture period per week.

ii) One credit for every three periods of laboratory or practical work per week

6. 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.

7. Duration:

The duration for a Five year Integrated Masters Programme in any subject is Ten semesters.

8. Structure and Programme:

The Five year Integrated Masters Programme will consists of:

i) Core courses and Common courses which are compulsory for all students.

ii) Elective courses which students can choose from amongst the courses offered by the other Departments of Science faculty as well as by the Departments of other faculties of the University or within the Department.

9. Attendance:

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

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.

10. Examinations:

The internal assessment for each course theory papers carries 25% marks and is based on two sessional 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	Viva and 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.

11. 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%

12. Marks and Grading

A student cannot repeat the assessment of Sessional Test-I and Sessional 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.

13. 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 Masters 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.

14. 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 (Five Year Integrated) Programme

Programme Code: SEAR51

Programme Structure

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

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19ITAC11	Language-I: Course 1 Tamil /French/Hindi	3		3	25	75	100
19IENC12	Language–II: Course 1 English Through Literature-I Prose	3		3	25	75	100
19ICEC13	Civics, Health Sciences & Environmental Awareness	3		3	25	75	100
19IGYT14	Core 1: Physical and Dynamic Geology	4		4	25	75	100
19IGYT15	Ancillary-I: Chemistry -I	4		4	40	60	100
	Elective 1: Department Elective	3		3			
	Total Credits			20			
Semester-II							
19ITAC21	Language-I: Course 2 Tamil /French/Hindi	3		3	25	75	100
19IENC22	Language– II: Course 2 English Through Literature-I Poetry	3		3	25	75	100
19ICEC23	Computer Applications - I	4		3	25	75	100
19IGYT24	Core 2: Paleontology	4		4	25	75	100
19IGYP25	Core 3: Practical–I Paleontology		12	6	40	60	100
19IGYA26	Ancillary- I: Chemistry –II	4		3	25	75	100
19IGYP27	Ancillary Practical- I: Chemistry		12	6	40	60	100
	Total Credits			28			
Semester-III							
19ITAC31	Language-I: Course 3 Tamil /French/Hindi	3		3	25	75	100
19IENC32	Language–II: Course 3 English Through Literature-III Drama	3		3	25	75	100
19IGYT33	Core 4: Structural Geology	4		4	25	75	100
19IGYP34	Core 5: Practical–II Structural Geology		6	6	40	60	100
19IGYA35	Ancillary- II: Physics- I Course 1	4		4	25	75	100
	Elective 2: Department Elective			3			
				23			
Semester-IV							
19ITAC41	Language–I: Course 4 Tamil /French/Hindi	3		3	25	75	100
19IENC42	Language–II: Course 4 English Through Literature-IV Short story	3		3	25	75	100
19IGYT43	Core 6: Mineralogy and Crystallography	4		4	25	75	100
19IGYP44	Core 7: Practical-III Mineralogy and Crystallography		12	6	40	60	100
19IGYA45	Ancillary-II: Physics- II Course 2	4		4	25	75	100
19IGYP46	Ancillary Practical-II Physics Course 3		12	6	40	60	100
	Total Credits			26			

Semester-V							
19IGYT51	Core 8: Stratigraphy and Indian Geology	4		4	25	75	100
19IGYT52	Core 9: Economic Geology	4		4	25	75	100
19IGYT53	Core 10: Igneous Petrology	4		4	25	75	100
19IGYT54	Core 11: Metamorphic and Sedimentary Petrology	4		4	25	75	100
19IGYP55	Core 12: Practical- IV Economic Geology, Igneous, Metamorphic and Sedimentary Petrology		12	6	40	60	100
	Elective 3: Department Elective			3			
	Total Credits			25			
Semester-VI							
19IGYT61	Core 13: Field Geology	4		4	25	75	100
19IGYT62	Core 14: Fundamentals of Geospatial Technology	4		4	25	75	100
19IGYT63	Core 15: Mineral Beneficiation	4		4	25	75	100
19IGYT64	Core 16: Applied Geology	4		4	25	75	100
19IGYP65	Core 17: Practical-V Cartography and Aerial Photography and Mineral Dressing (Engg. Dept)		12	6	40	60	100
	Total Credits			22			
Semester-VII							
19IGYT71	Core 18: Structural geology, Geomorphology & Tectonics	4		4	25	75	100
19IGYT72	Core 19: Mineralogy and Mineral Optics	4		4	25	75	100
19IGYT73	Core 20: Indian Stratigraphy and Marine Geology	4		4	25	75	100
19IGYP74	Core 21: Practical-VI Structural Geology, Mineralogy and Mineral optics.		12	6	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Total Credits			21			
Semester-VIII							
19IGYT81	Core 22: Economic Geology, Mining Geology and Ore Genesis	4		4	25	75	100
19IGYT82	Core 23: Coal and Petroleum Geology	4		4	25	75	100
19IGYT83	Core 24: Remote Sensing and GIS	4		4	25	75	100
19IGYP84	Core 25: Practical-VII Economic Geology, Ore petrology and Remote Sensing & GIS and Survey (Engg. Dept)		12	6	40	60	100
	Elective 5: Interdepartmental Elective	3		3	25	75	100
	Elective 6: Department Elective	3		3	25	75	100
	Total Credits			24			
Semester-IX							
19IGYT91	Core 26: Igneous and Metamorphic Petrology	4		4	25	75	100
19IGYT92	Core 27: Sedimentology and Micropaleontology	4		4	25	75	100
19IGYT93	Core 28: Atmospheric Sciences	4		4	25	75	100
19IGYP94	Core 29: Practical-VIII Petrology, Sedimentology and Micropaleontology and Geological mapping report.		12	6	40	60	100
	Elective 7: Interdepartmental Elective	3		3	25	75	100
	Elective 8: Department Elective	3		3	25	75	100
	Total Credits			24			

Semester-X							
19IGYT101	Core 30: Geophysical Exploration	4		4	25	75	100
19IGYT102	Core 31: Geological and Geochemical Exploration	4		4	25	75	100
19IGYT103	Core 32: Hydrogeology and Engineering Geology	4		4	25	75	100
19IGYP104	Core 33: Practical-IX Geophysics, Geochemistry, Hydrogeology and Engineering Geology. Mining industry visit report.		12	6	40	60	100
19IGYP105	Project work Dissertation Viva-voce		12	6		60 40	100
	Total Credits			24			
	Semesters I-X Total Credits			237			

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.**

INTERDEPARTMENT ELECTIVE COURSES (IDE)

S.No.	Course Code	Course Title	Department	L	P	Credits	Marks		
				Hrs			Int. Asses	End Sem. Exam	Total
1	19 ISOSE 75.1	Soft Skills	**English**	3	0	3	25	75	100
2	19 IMATE 86.1	Discrete Mathematics	**Mathematics**	3	0	3	25	75	100
3	19 IMATE 86.2	Numerical Methods		3	0	3	25	75	100
4	19 IMATE 96.1	Differential Equations		3	0	3	25	75	100
5	19 ISTSE 86.1	Statistical Methods	**Statistics**	3	0	3	25	75	100
6	19 ISTSE 86.2	Mathematical Statistics		3	0	3	25	75	100
7	19 ISTSE 96.1	Bio-Statistics		3	0	3	25	75	100
8	19 IPHYE 86.1	Classical Mechanics and Special Theory of Relativity	**Physics**	3	0	3	25	75	100
9	19 IPHYE 86.2	Physics of the Earth		3	0	3	25	75	100
10	19 IPHYE 96.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11	19 IPHYE 96.2	Energy Physics		3	0	3	25	75	100
12	19 ICHEE 86.1	Applied Chemistry	**Chemistry**	3	0	3	25	75	100
13	19 ICHEE 96.1	Basic Chemistry		3	0	3	25	75	100
14	19 ICHEE 96.2	Instrumental Methods of Analysis		3	0	3	25	75	100
15	19 IBOTE 86.1	Plant Tissue Culture	**Botany**	3	0	3	25	75	100
16	19 IBOTE 86.2	Plant Science – I		3	0	3	25	75	100
17	19 IBOTE 96.1	Gardening and Horticulture		3	0	3	25	75	100
18	19 IBOTE 96.2	Plant Science – II		3	0	3	25	75	100
19	19 IZOOE 86.1	Animal Culture Techniques	**Zoology**	3	0	3	25	75	100
20	19 IZOOE 96.1	Environmental Science		3	0	3	25	75	100
21	19 IBIOE 86.1	Basic Biochemistry	**Biochemistry & Biotechnology**	3	0	3	25	75	100
22	19 IBIOE 86.2	Basic Biotechnology		3	0	3	25	75	100
23	19 IBIOE 96.1	Biochemical Techniques		3	0	3	25	75	100
24	19 IBIOE 96.2	Immunology		3	0	3	25	75	100
25	19 IMIBE 96.1	Microbiology	**Microbiology**	3	0	3	25	75	100
26	19 ICSCE 86.1	R Programming	**Computer & Information Science**	3	0	3	25	75	100

DEPARTMENT ELECTIVE COURSES (DE)

Course Code	COURSE TITLE	L	P	C	Int. Marks	Exter. Marks	Total Marks
		Hrs					
19IGYE16.1	Fundamentals of Geology	3		3	25	75	100
19IGYE16.2	Physics and Chemistry of the Earth	3		3	25	75	100
19IGYE36.1	Fundamental of Applied Geology	3		3	25	75	100
19IGYE36.2	Geo-Heritage and Geo-Tourism	3		3	25	75	100
19IGYE56.1	Introduction to Geological Software	3		3	25	75	100
19IGYE56.2	Natural resources	3		3	25	75	100
19IGYE85.1	Environmental geosciences and disaster management	3		3	25	75	100
19IGYE85.2	Medical Geology	3		3	25	75	100
19IGYE95.1	Instrumentation and Analytical Techniques	3		3	25	75	100
19IGYE95.2	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)

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.

Semester-I **19IGYT14: Physical and Dynamic Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To know about the basic principles of Geology, Composition of the earth, Age of the earth.
- To Know Earth's various exodynamic processes like weathering and action of geological agents and endodynamic processes like earthquake, volcanoes and tectonic process.

Unit-1

Geology scope and importance. Geology in relation to other branches of science. Brief note on geological time scale. Solar system – outer and inner planets. Earth as a member of the solar system and its relation to other planets – Size and Density of the Earth. Origin of the Earth – Nebular, Planetesimal, Tidal and Dust cloud hypotheses; their merits and demerits. Age of the Earth. Interior of the earth – structure and constituents.

Unit-2

Volcanoes – types of volcanic eruption – central vent and fissure types; dormant and extinct volcanoes. Types of volcanic cones; classification of volcanoes based on the nature of volcanic activity; Products of volcanoes – distribution and causes of volcanism.

Unit-3

Earthquakes–Definition– Seismic waves, definition of Focus, Epicenter and isoseismic lines. Seismograph and seismogram – Time, distance graphs – effects and causes of earth quakes – Richter's scale of earthquake–Mercalli's intensity scale–Distribution of earthquake.

Unit-4

Concepts of Geomorphology. Weathering and Mass wasting. Introduction: Fundamental concepts; Cycle of erosion; Base level. Weathering: Review of factors influencing weathering. Physical, Chemical and Biological weathering.

Unit-5

Geological work and landforms produced by Wind and groundwater. Drainage Patterns. River capture, river meandering, stream rejuvenation, river terraces, entrenched meanders, braided streams

Books for study:

1. Arthur Holmes, (1992) Principles of Physical Geology, Edited by Duff.P. 4th Ed. Chapman and Hall, London.
2. Jacobs, J.A R.D.Russel, and J.T.Wilson, J.T(1982). Physics and Geology,
3. Miller, (1949) An Introduction to Physical Geology, East West Press Ltd.,
4. Spencer,E.V (1962), Basic concepts of physical Geology, Oxford & IBH,
5. Charles Fletcher (2014) Physical Geology: The sciences of Earth, 2nd ed. Willey
6. Mohapatra.G.B. (2014) Text book of Geology. CBS ed.

Reference Books / Supplementary reading:

1. Don Leet, & Sheldon Judson, (1960), Physical Geology, Prentice Hall & Co.,
2. Gorshkov,G, G & A.Yakushova,A (1967).Physical Geology, Mir publishers, Moscow.
3. Wyllie, P.J (1971), The Dynamic Earth, John Wiley and Sons.
4. Vincent S. Cronn and Dennis Tasa (eds) (2017) Physical Geology. Pearson Publishers, New York. 15th edition.
5. Jain Sreepat (2014) Fundamentals of Physical Geology. Springer Nature India Pvt. Ltd. New Delhi

Course Outcomes

- Students gain knowledge on geosciences and its scope.

- The students will gain knowledge about the geological processes that occur in the earth crust.
- To know their causes and their effect on the structures of the earth crust and the landforms of the surface.

Outcome Mapping

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

Semester-II **19IGYT24: Paleontology** **Credits: 4**
Hours:

Learning Objective (LO):

- To know about the general outline of the vertebrate, invertebrate and plant fossils, their mode of preservation, classification.
- To understand the various characters of important phyla, their morphology, distribution and geologic range.
- To study the significances on environmental reconstruction and in petroleum and coal industries.

Unit-1
Definition of Palaeontology; General classification of Animal kingdom; Habitats and Habits of animals. Nature and mode of preservation of fossils: Unaltered hard parts, altered hard parts, petrification, permineralisation, carbonisation, recrystallisation, silification.. Index fossil. Uses of fossils,

Unit-2
General morphology, classification, geological history and environmental significance of the following with examples: Phylum- Mollusca - Classes - Pelecypoda, Gastropoda and Cephalopoda; Phylum - Brachiopoda.

Unit-3
General morphology, classification, geological history and environmental significance of the following with examples: Phylum- Echinodermata; Phylum-Coelenterata- Class-Anthozoa (Corals).

Unit-4
General morphology, classification, geological history and environmental significance of the following with examples: Phylum-Arthropoda- Class- Trilobita; Phylum - Hemichordata- Class-Graptoloidea.

Unit-5
Classification of Plant kingdom; General morphology, classification, geological history and environmental significance of the following: Glossopteris, Gangamopteris, Ptilophyllum, Lepidodendron, Calamites, Sigillaria and Phyllotheca.

Books for study:

1. Robert R. Shrock and William H., Twenhofel, 1953, Principles of Invertebrate Paleontology Mc Graw-Hill Book Co
2. H.Woods, 1961, Invertebrate Paleontology, Cambridge University press
3. R.C.Moore, C.G., Lalicker and A.G. Fisher, 1952. Invertebrate Fossils, Mc Graw Hill Book Co
4. H.H.Swinerton, 1961, Outlines of Paleontology, Edward Arnold Publisher Reference Books
5. Jones, 1989,Introduction to Microfossils

6. P.C. Jain and M.S. Anantharaman, 1989, An introduction to paleontology, Vishal Publication, Delhi
7. K.N. Prasad, 1999, An Introduction to palaeobotany, APH Publications Corporation

Reference Books / Supplementary reading:

1. W.W. Berry, 2003, An Introduction to Paleontology, Sonali publications
2. Derek V.Ager, 1963, Principles of Paleoecology, Mc Graw Hill Book Co
3. Benton, M.J. 1990, Vertebrate Paleontology, John Wiley
4. Unwin Hyman, , 1971, Vertebrate Paleozoology, John Wiley
5. David.M. Raup, Steven. M. Stanley, 2004, Principles of Palaeobotany, 2nd Ed, CBS publications

Course Outcomes

- The student will gain knowledge about the classification of animal kingdom, their distribution and importance as fossil.
- Students will able to understand animal life in the past of different phyllum, their distribution.
- Able to understand the importance of studying plants preserved as fossils.
- Understand the importance of studying the fossils in the stratigraphic record.

Outcome Mapping

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

Semester-II **19IGYP25: Practical – I Palaeontology** **Credits: 6**
Hours:

Learning Objective (LO):

- To familiarize in the identification of important fossil, ecology and their significance to the geological environment**.**

EXERCISES:

1. **Mollusca: Pelecypoda** - Arca, Glycimeris (Pectenculus) Inoceramus, Ostrea, Alectryonia, Pecten, Spondylus, Trigonia, Pholadomya, Cardita, Hippurites, Cardium, Venus, Unio, Megalodon, Meretrix, Gryphaea, Exogyra.
2. **Gastropoda:-** Natica, Trochus, Turbo, Turritella, Fusus, Conus, Murex, Physa, Busycon
3. **Cephalopoda:** Natilus, Goniatites, Ceratities, Ammonite, Phyiloceras, Acanthoceras, Scaphites, Turrilites, Belemininites
4. **Brachiopoda:** Lingula, Orthis, Productus, Pentamerus, Rhynoconella, Terebratula, Atrypa, Spirifer and Athyris.
5. **Echinoidea:** Cidaris, Hemicidaris, Stigmatophygus, Holaster, Hemiaster, Micraster.
6. **Echinodermata :Crinoids;** Encrinus, Marsupites
7. **Blastoidea:** Pentremites
8. **Arthropoda:Trilobita**; Paradoxides, Olinus, Ollenellus, Calymene, Phacops
9. **Hemichordate:graptoloidea;** Tetragraptus, didymograptus, Phyllograptus, Diplograptus, Monograptus, Rastites

10. **Plant fossils:** Calamites, Sphenophyllym, lepidodendron, Sigillaria, Glossopteris, Gangamopteris, Gondwanadium, Ptilophyllum

Course Outcomes

- The students will knowledge in identification of Pre historic species.
- Gain knowledge in ecology of animal and plant species.
- Able to understand the evolution of organism in different periods.

Outcome Mapping

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

Semester-III **19IGYT33: Structural Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To learn about the different geological structures and dynamics, including the methods of geological mapping.
- To study the mechanical properties and deformation structures in rocks.
- To study different types of structures and their classification.

Unit-1
Methods of representing physiographic features, topographic maps, preparation and uses of geologic maps. Attitude of planes – strike and dip of the formation – trends of outcrops and rule of 'V' Relation between true and apparent dips – width of outcrops – true and vertical thickness.

Unit-2
Definition of stress and strain, compressive and tensile stresses, shearing stress, couple, three stages of deformation. Morphology, geometrical characteristics and classification of structures.

Unit-3
Folds: Geometry and classification of folds. Description of single folds - descriptive study of fold system - Description of folds as seen in the profile - criteria for recognition of folds in field and map

Unit-4
Fault: Fault terminology – Geometrical and genetic classification of faults – Criteria for recognition of faults. Faulting and earthquakes. Concept of Shear zone.

Unit-5
Joints: Joint sets and systems – joint surface - relations of joints to other structures - geometric and genetic classifications. Repetition of outcrops due to erosion, folding and faulting. Unconformities: General Characteristics - Kinds of Unconformities - Criteria for recognition – overlap and off lap. Criteria to distinguish unconformities from faults.

Books for study

1. Billings, M.P. (1972) Structural geology 3 ed. Prentice Hall, Inc. Englewood Clifs, N.J.
2. Hills, E.S. Elements of Structural Geology, 2nd ed. Wiley, New York.
3. F.H.Lahee (2002) Field Geology 6th ed. Mc Graw Hill Book company Inc. New York
4. R.R. Compton (1962) Field Geology, Wiley Publishers.

Reference Books / Supplementary reading:

1. Bruce E. Hobbs,Winthrop.D.Means,Paul F.Williams - An outlines of structural geology – John Wiley & Son, New York.
2. Himus and Sweeting – The elements of Filed Geology – University Tutorial Press Ltd. - London.
3. Gokhale. N.W.(2014) Theory of structural geology.CBS ed.

Course Outcomes

- Students will understand about the rock dynamics.
- They will understand the mechanical deformation of stress and strain for the formation various structures.
- They will gain knowledge on the mechanism of folds, faults and joints.

Outcome Mapping

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

Semester-III **19IGYP34: Practical – II Structural Geology** **Credits: 6**
Hours:

Learning Objective (LO):

- They will be trained for the field measurement techniques like true dip, apparent dip, and estimation on the thickness of bed.

EXERCISE:

a. Calculation of True dip and apparent dip.
b. Determination of Throw/Heave/ Stratigraphic separation
c. Estimation of Thickness of beds,
d. Methods of representing physiographic features on geological and contour maps
e. Interpretation of geological and contour maps.

Course Outcomes

- The students will have practical experience on the measurement of Geometry of geological formation and understand the mapping of the geological features.

Outcome Mapping

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

Semester-IV **19IGYT43: Mineralogy and Crystallography** **Credits: 4**
Hours:

Learning Objective (LO):

- To learn about the physical and optical properties of rock forming minerals.
- To know about the structure, physical and chemical properties of ortho, ring, sheet, chain and framework silicates.
- To know about the nature, forms, habit, symmetry elements, measurement of interfacial angles and twins in crystals

Unit-1

Physical properties of minerals: Density & specific gravity, mechanical cohesion, color and luster, magnetism, electrical properties. Definition, explanation and examples of the following: Isomorphism. Dimorphism, Polymorphism, Isodimorphism, Paramorphism, Pseudomorphism – Molecular and empirical formulae of minerals.

Unit-2

Plane polarized light, double refraction, snell's law. Optical properties of minerals: colour, form, cleavage, refractive index, relief, alteration, inclusions, zoning, pleochroism, pleochroic haloes, twinkling, isotropism and anisotropism, extinction, polarization colours, birefringence, twinning. Optic sign, uniaxial and biaxial interference figures. Primary and secondary optic axes, optic axial angle measurements, optic orientation. Dispersion in crystals, optic anomalies.

Unit-3

Crystal structure and classification of silicates, Crystallization and occurrence of Minerals in igneous, metamorphic and sedimentary rocks. Ortho silicates, Ring & Di silicates, Chain silicates, Sheet silicates and Framework silicates.

Unit-4

Physical and optical properties, chemical composition and mode of occurrence of Quartz group, Feldspar group, Feldspathoid group, Amphibole Group and Pyroxene Group minerals.

Unit-5

Symmetries and classes of systems. Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinc and Triclinic. Holohedral forms, Hemihedrism,Tetratohedrism. Hemimorphic forms. Enantiomorphism. Crystal growth, Irregularities in crystals. Twins: Simple and contact twins, Interpenetration twins, polysynthetic twin. Twin laws.

Books for study:

1. Dana, E.S.(1949) A text book of Mineralogy, Asia Publishing House
2. Phillips, P.C. (1963) An introduction to Crystallography, Longmans Green & Co.
3. Berry Mason, L.G. 1961, .Mineralogy, W.H.Freeman & Co.,
4. Deer, W.A. Howie, R.A. and J.Zussman, 1966, An Introduction to the Rock Forming minerals, Longmans.
5. Kerr, B.F.,2014, Optical Mineralogy 4th Ed. Mc Graw Hill, New York.
6. Bexter Perkins (2011) Mineralogy 3rd Ed. PHI

Reference Books / Supplementary reading:

1. Read, H.H.(1962) (2005) Elements of Mineralogy, 27th edition, W.H. Freeman & Co.
2. Wade, F.A & Mattox, R.B (1960), Elements of Crystallography and Mineralogy, Harper & Bros.
3. Alexander N.Winchell, 1968, Elements of Optional Mineralogy, Parts I and II, Wiley Eastern (P) Ltd., London.
4. Ernest, E.Walhstrom, 1960, Optional Crystallography, John Wiley & Sons,

Course Outcomes

- Students will gain knowledge of the minerals and their formation.
- Students will get the knowledge of the crystal structure.
- Students will get knowledge of physical & chemical properties of minerals.
- Understand the basics of crystals, formation and their classification.

Outcome Mapping

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

Semester-IV **19IGYP44: Practical – III Mineralogy and Crystallography** **Credits: 6**
Hours:

Learning Objective (LO):

- To get knowledge on the identification of mineral by using microscope and in hand specimen.
- To know the geometry of crystal models and to study the crystallographic features.

EXERCISES:

a. Megascopic identification of Quartz group, Feldspar group, Feldspathoid group, Pyroxene group, Amphibole group.
b. Microscopic study of Quartz group, Feldspar group, Feldspathoid group, Pyroxene group, Amphibole group.
c. Identification of 32 crystal class of different systems symmetry elements.

Course Outcomes

- Students will have the practical experience to identify the minerals through Megascope and microscope.
- They also get knowledge on the crystal face, symmetry and forms through the models.

Outcome Mapping

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

Semester-V **19IGYT51: Stratigraphy and Indian Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To learn about the geological time scale, principles and concepts of stratigraphy.
- To know the various physigraphic divisions of India.
- To know the distribution of rocks at various geological time.

Unit-1

Introduction to stratigraphy. Geological time scale. Principles and laws of stratigraphy. Various stratigraphic nomenclatures. Concepts of dynamic stratigraphy (biostratigraphy, chemostratigraphy, seismic stratigraphy and sequence stratigraphy)

Unit-2

Physiographic division of India- a comparative study of physiographic divisions. Major stratigraphical divisions and their equivalents in India. Brief account of classification, lithology, structures and fossil content of Archaean and Cuddapah Groups.

Unit-3

General characteristics and descriptive study of the following stratigraphic formations of Vindhyan Super Group, Cambrian of Salt range-Age of Saline series, Permo carboniferous of Kashmir-Umaria marine beds.

Unit-4

Gondwana super group -divisions, brief account on climate and conditions of sedimentation, economic importance. Deccan trap and their age-Inter trappeans and Infra trappeans.

Unit-5

Triassic of Spiti and Kashmir valley-Jurassic of Kutch, Cretaceous of Trichinopoly Tertiary and Quaternary rocks of Tamil Nadu.

Books for study:

1. M.S.Krishnan, 2014, The Geology of India and Burma 6th Ed., CBS Publishers and distributors, Delhi.
2. D.N. Wadia, 1973, Geology of India –Tata McGraw Hill Publishing Company, New Delhi.
3. Ravindra Kumar, 2010, Fundamentals of Historical geology and Stratigraphy, New Age International.

Reference Books / Supplementary reading:

1. Weller, J.M. 1960, Stratigraphic principles and practice, Harper & Bros, Publishers, New York.
2. Grabau, A.W, 1960, Principles of Stratigraphy, Dower publications.
3. Wadia, D.Tata 1975.Geology of India, McGraw Hill Pub. Co, 4th Ed.
4. King, 1967, An Introduction to oceanography, McGraw Hill Book Co., Newyork.
5. Ravindra Kumar, 1985, Fundamentals of Historical Geology and Stratigraphy of India,

Course Outcomes

- Students gain knowledge on the rock successions and the interpretation in terms of time scale.
- They will have the knowledge of the physiographic division and rock successions in India.
- Understand the distribution of various formations at different geological period.

Outcome Mapping

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

Semester-V **19IGYT52: Economic Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To gain knowledge on the classification of mineral deposits.
- To understand the process of formation of mineral deposits.
- To have a knowledge on the important ores, their occurrence and distribution in India.
- To understand mineral economics and its concepts.

Unit-1

An outline of the processes of formation of mineral deposits. Magmatic, sublimation, contact metasomatic, hydrothermal, residual, placer, oxidation and supergene sulphide enrichment, evaporation and metamorphism. Banded iron ore formation. Origin of phosphatic deposits.

Unit-2

Controls of ore localization, metallogenic epochs and provinces, geologic thermometers, classification of ore deposits – Lindgrens and Batman's classification.

Unit-3

Important ores, their composition, mode of occurrence, uses and distribution in India with reference to the following metals: Aluminium, Gold, Silver, copper, Lead, Zinc, Iron, Manganese, Chromium, Titanium, Uranium, Thorium, Beryllium and Zirconium.

Unit-4

Qualities, mode of occurrence and distribution in India of the raw material required for the following industries/refractory's : Abrasive, Ceramic, Glass, Cement, Paint and Pigment, and Fertilizer.

Unit-5

Building stones and gemstones – quality, mode of occurrence and distribution in India. Mineral wealth of Tamil Nadu. Mineral economics and its concepts. Classification and mineral resources.

Books for study:

1. A.M.Bateman (2012) Economic Mineral Deposits – John Wiley & Sons.
2. Gokhale and T.C. Rao – Ore deposits of India – Thomson 2nd ed. Faridabad.
3. S.Krishnaswamy (1979) India's Mineral Resources – Oxford IBH Publishing Co.
4. Lindgren, (1933) Mineral deposits, McGraw Hill
5. Deb.L (1980) Industrial Minerals and Rocks, Allied Publishers Pvt. Ltd.
6. Sharma M.L. and Ram K.V.S. India's Economic Minerals, Dhanbad.

Reference Books / Supplementary reading:

1. B.P, Tiraot and D.H.Welte, Petroleum formation and occurrence – Springer
   Chapman – Petroleum Geology
2. Smirnov – Geology of Mineral deposits, Mir.Publishers, Moscow.
3. D.N. Wadia (1953) Geology of India.
4. Umeshwar Prasad (2015) Economic Geology. 2nd ed. CBS publishers
5. Anthony M Evans (2012) Ore geology & Industrial minerals – an Introduction 3rd ed. Wiley Blackwell science publications

Course Outcomes

- Students gain knowledge on the earth material that can be used economic resources.
- Students will able to understand the properties and distribution of ore minerals in India.
- Students will understand the various precious, metallic and non-metallic minerals occurrences and distribution throughout India.

Outcome Mapping

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

Semester-V **19IGYT53: Igneous Petrology** **Credits: 4**
Hours:

Learning Objective (LO):

- To understand origin and magma crystallization process of rocks.
- To know the characteristic structures and textures of Igneous rocks.
- To understand the concept and processes of metamorphism.
- To understand the sedimentary process, sedimentary textures and structures.

Unit-1

Nature and scope of petrology – the earth shells and the chemical composition of the earth. Composition and constitution of magmas. Forms of igneous rocks- Concordant and discordant forms: Sills, laccoliths, dykes and cone sheets, phaccolith, conoliths, batholiths, multiple intrusions, composite intrusions

Unit-2

Structure and texture of igneous rocks. Structures – vesicular, amygdaloidal, blocky lava, Ropy lava, pillow structure, flow structure, sheet joints, mural joints, columnar joints, rift and grain. Textures – definition, elements of texture, kinds of textures – equigranular, inequigranular, directive, intergrowth, reaction, Corona, Xenolithic and others

Unit-3

Crystallization of a unicomponent magma – phase equilibria studies of binary and ternary silicate system: Albite – Anorthite systems, Forsterite-Silica system Albite – Anorthite- Diopside system, Anorthite–Forsterite– Silica system, Diopside–Forsterite–Silica system, with reference to petrogenesis. crystallization of basaltic magma.

Unit-4

Petrographic characteristics of Granite, Granodiorite, Syenite, Diorite, Gabbro and their hypabyssal and volcanic equivalents. Petrographic characters and origin of Pegmatites and Aplites, Lamprophyres, Alkaline rocks, Ultrabasic rocks and Anorthosites.

Unit-5

Bowen's reaction principle and its bearing on petrogenesis of igneous rocks. Diversity of igneous rocks in space and time – Evidences and theories of differentiation and assimilation.

Books for study:

1. Anthony Hall, 1987, Igneous petrology, ELBS Publihsers,
2. Barth, T.F.W.1962, Theoretical petrology, John & Wiley and sons. Principles of petrology, G.W.Tyrell, ., 1989, Methuren and Co (Students ed.)
3. Best,M.G. 1986, Igneous petrology, CBS.

4. Turner, F.J. & Verhoogen, J. 1960, Igneous and Metamorphic petrology, Mc Graw Hill Book Co
5. Wahlstrom , E.E., 1961, Theoretical Igneous petrology, John Wiley & Sons

Reference Books / Supplementary reading:

1. Nockolds, S.R. Knox, R.W.O B. Chinner, G.A.1979, Petrology for students, , Cambrige University press.
2. Philipotts,A.(1992) Igneous and Metamorphic petrology, Prentice Hall.
3. Williams, H. Turner, F.J. and Ghilbert, C.M., 1954, Petrography W.H.Freeman and Co.
4. Alexander R. Mc Birney (2007) Igneous Petrology; Jones and Bartlett Publisher.
5. Bose,M.K.1997, Igneous petrology, World press

Course Outcomes

- Students are will gain knowledge on the rocks and the conditions under which they form.
- Students can understand the properties and classification of different types of igneous rocks.
- Students are able to understand the process of formation of igneous rocks.

Outcome Mapping

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

Semester-V **19IGYT54: Metamorphic and Sedimentary Petrology** **Credits: 4 Hours:**

Learning Objective (LO):

- To understand origin and metamorphic process of rocks.
- To know the characteristic structures and textures of metamorphic and sedimentary rocks.
- To understand the concept and processes of metamorphism.
- To understand the sedimentary process, sedimentary textures and structures.

Unit-1

Definition and agents of metamorphism, Kinds of metamorphism and its products, Classification and nomenclature. Petrography of metamorphic rocks: Schists, gneisses and granulites.

Unit-2

Texture and structure of metamorphic rocks. Pressure- temperatures- composition diagrams for paragenetic studies- ACF and AKF diagrams. Zones, grades and facies concepts of metamorphism: Eskola, Turner-Verhoogen, Winkler's concepts.

Unit-3

Metamorphism and deformation. Metasomatism and metasomatic process. Pneumatolyitc metamorphism–Skarn rock -Injection metamorphism and Auto metamorphism. Petrographic description of the following rock types – Quartzite, Slate, Schist, Gneiss, Marble and Hornfels.

Unit-4

Introduction to sedimentary petrology. Brief note on disintegration, decomposition and transportation, classification and composition of sedimentary rocks. Physical properties of particles- surface texture, shape, sphericity and roundness. Mineral stability.

Unit-5

Clastic and nonclastic textures of sedimentary rocks. Structures of sedimentary rocks. Folk and Dunham's classification. Diagenesis and lithification processes. Petrography of clastic and nonclastic rocks.

Books for study:

1. Turner, F.J. & Verhoogen, J. 1960, Igneous and Metamorphic petrology, Mc Graw Hill Book Co
2. Folk, R.L. (1961). Petrology of Sedimentary rocks, Hemphills,
3. Pettijohn, F.J, (1975). Sedimentary rocks, Harper & Bros. 3rd Ed.
4. Richard C.Selly (1988) Applied Sedimentolgy- Acdemic Press, Harcourt Brace Jovanovic Publishers, London

Reference Books / Supplementary reading:

1. Philipotts,A.(1992) Igneous and Metamorphic petrology, Prentice Hall.
2. Roy Lindholm, (1989), A Practical Approach to Sedimentology, Allen and Unwin, USA.
3. Sanders, G.M, (1978). Principles of Sedimentology, Friedman, E.J.John Wiley and sons, New York.

Course Outcomes

- Students are will gain knowledge on the metamorphic and sedimentary rocks and the conditions under which they form.
- Students can understand the properties and classification of different types of metamorphic and sedimentary rocks.
- Students are able to understand the process of formation of metamorphic and sedimentary rocks.

Outcome Mapping

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

Semester-V | **19IGYP55: Practical – IV Economic Geology, Igneous, Metamorphic and Sedimentary Petrology** | **Credits: 6 Hours:**

Learning Objective (LO):

- To develop skill and abilities in the identification of rocks with their texture.
- Determination of genesis both in hand specimen and thin sections.
- To know about different metallic ores, genesis and their distribution.
- To know the non metallic minerals and their industrial applications, distribution, occurrence.

ECONOMIC GEOLOGY:

Megascopic identification and study on mode of occurrence, origin and importance of economic, Industrial and ore minerals.

PETROLOGY:

I. Megascopic identification and description of the following rocks in hand specimen:

Igneous Rocks : Mica Granite, Hornblende Granite, Pyroxene Granite, Tourmaline Granite, Graphic Granite, Pegmatite, Aplite, Mica Syenite, Hornblende Syenite, Pyroxene Syenite, Nepheline Syenite, Diorite, Gabbro, Norite, Dunite, Pyroxenite, Peridotite, Anorthosite, Dolerite, Dolerite Porphyry, Rhyolite, Trachyte, Andesite, Felsite, Basalt, Obsidian Pitchstone, Pumice, Volcanic Tuff, Volcanic breccias and Vitrophyre.

Sedimentary Rocks : Conglomerate, Breccia, Sandstone, Arkose, Grit, Flagstone shale, Laterite, Limestone, Clay, Chalk, Flint, Chert, Phosphatic Nodule, Peat, Lignite, Bituminous Coal and Anthracite.

Metamorphic Rocks : Mica gneiss, Hornblende schist, Chlorite Schist, Chlorite mica schist, Chlorite garnet schist, Mica garnet schist, Mica staurolite schist, Talc schist, Graphite Schist, Phyllite, shale, slate, Quarzite, Marble, Dolomite, Quartz magnetite rock, Amphibolite, Eclogite, Khondalite, Gondite, Charnockite and Calc granulite.

II. Preparation of thin sections of rocks and Microscopic identification of 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,

Course Outcomes

- Students will have hands on training to identify the economic and ore minerals.
- Students will have practical experiences on the identification of the rock specimen
- To know about the preparation of thin section of rocks

Outcome Mapping

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

Semester-VI **19IGYT61: Field Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To understand the need of field investigation and mapping.
- To have knowledge on the basic field equipments applications.
- To know about the field sampling techniques.

Unit-1

Role of Field geology and field geologist- Field methods and Types of investigations- Purpose of Geological mapping- Field maps- Scale of maps. Topographic expressions and relief-Investigation of out crops-inlier and outlier-Soils and vegetation.

Unit-2

Previous literature and importance - Selection of camp site- Climate and region: Arid, Semiarid and Mountain. Organisation of field camp-Requirements and precautions-Equipment and supplies-Basic, Additional, Supplementary, Special and Optional. Components and uses of Clinometer and Brunton Compass.

Unit-3

Geological Mapping-General considerations- Depiction of relief- Latitude and longitude-Map Grids-Investigation of surface features, cuttings, quarries and mines. Measurement of strike and dip-Bearing and reading directions. Outline of field work with igneous, sedimentary and metamorphic rocks.

Unit-4

Samples and sampling methods- Trimming of hand specimens, fossil specimens, mineral specimens. Numbering, labelling, packing and storage of samples. Symbols for geologic maps and lithology. Marking on maps-Mounting and folding of field maps. Field photographs. Applications of computer in preparation of geological map and writing report.

Unit-5

General geological setting-structure and tectonics of Tamil Nadu. Distribution of important rock types of Tamil Nadu. Geoheritage sites of Tamil Nadu.

Books for study:

1. F.H.Lahee (2002) Field geology, 6th ed. McGraw Hill, Publishers.
2. C.L.Dake and C.S.Brown. Interpretation of topographic maps,
3. J.W.Low (1957) Geological field methods, Harper & Brothers publishers.
4. R.R. Compton (1962) Field Geology, Wiley Publishers.
5. S.M.Mathur (2015) Guide to Field Geology, PHI Learning Private Limited, Delhi.

Reference Books / Supplementary reading:

1. J.D. Foresten. Principles of field and mining geology, Wiley Publishers
2. G.W.Himus and G.S.Sweeting. Elements of field geology,
3. G.W.Chiplonker (1960) Geological Maps, Dastane Bros., Pune.
4. W.B.Upton (1986) Landforms and topographic maps, John Wiley Publishers.
5. N.W.Gokhale (1987) Manual of geological maps, CBS Publishers and Distributors.

Course Outcomes

- The student will gain knowledge from the field work, for the preparation of maps
- They know about the different field sampling techniques.
- They will be trained for plotting of the orientation of the structural features.

Outcome Mapping

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

Semester-VI **19IGYT62: Fundamentals of Geospatial Technology** **Credits: 4**
Hours:

Learning Objective (LO):

- To understand fundamentals of cartography.
- To know about the concept of aerial photography and remote sensing
- To gain knowledge on geological map reading, map interpretation,
- To understand functioning of GPS and its applications.

Unit-1

Cartography as communication system – Scope of Cartography – The science and art of Cartography - Growth of modern cartography - major divisions in cartography. Evolution of cartography. Definition of Map – Classification of Maps - based on relief, Scale, and Information Characteristics – Earth as a Cartographic Problem – Shape, Gravity and Dimension of the Earth. Geographic Coordinates. Types of Map Projections.

Unit-2

Introduction, Terrestrial and Aerial photographs - vertical and oblique photographs - height determination contouring - photographic interpretations - stereoscopy – parallax bar- Flight Planning, Overlap and side lap. Stereoscope and stereo pair, Mosaics – types and construction. Photo Interpretation – interpretation elements - Analysis based on drainage, landforms and vegetation.

Unit-3

Remote Sensing – Definition and scope, History. Physics of Remote Sensing - Energy sources and Radiation principles, EMR and Spectrum, EMR interaction with Atmosphere - scattering, absorption, Atmospheric Window, EMR interaction with earth surface features - reflection, absorption, emission and transmission, Launch of space vehicle, Platforms - Types and characteristics of different remote sensing platforms. Sensors - Classification of remote sensors. Resolutions and scanning mechanism.

Unit-4

Priciples of Global Positioning System (GPS) - Introduction – GPS satellites – components – Satellite Ranging – codes. Different segments - space, control and user segments - satellite configuration - GPS signal structure - Orbit determination and representation. Basics of Geodesy, Applications and use of different software.

Unit-5

Definition of GIS, Evolution of GIS, Components of GIS – Hardware and Sofware. Types of data - Spatial and Non-spatial data. Data input – Manual, Run length code, digitization, automated scanning etc., Registration and Georeferencing. Data format - Raster and Vector data, advantage and disadvantages of Raster and Vector data. GIS software – Arc/GIS and QGIS.

Books for study:

1. Curran, P, (1985), Principles of Remote sensing, Longman, London.
2. Curran, P. Principles of Remote sensing, Longman, London, 1985
3. GIS - Principle and applications, vol.I ans vol. II edited by David J. Maguir, Micheal F Goodchild and David W Rhind, John Willy and Sons Inc.New York, 1991.
4. Lillesand, T. M and keifer, R. W,(1987), Remote sensing & Image interpretation, 3rd Ed., John Wiley and sons.
5. Miller, F. H. and Kikhali, E. M. (1980), Photogrammetry, Harper and Row Publishers, New York.
6. Pandey, S. N.(1987), Principles of application of photogeology. Wiley Eastern Ltd., New Delhi.
7. Robbinson, A, H. (1983), Elements of Cartography, John Willy and Sons, New York.
8. Sabins, F.F (1988). Remote sensing principles and interpretation, Freeman, Sanfrancisco.

Reference Books / Supplementary reading:

1. Alfred Leick, (2007) GPS Satellite surveying:, John Willy and Sons, New York
2. GIS - A computing perspective by Micheal F. Worboys, Taylor & Francis, 1995.
3. http://www.esri.com/news/arcnews/winter0102articles/gis-homeland.html visited on October 2002.
4. Miller, V. C. (1961), Photogeology, McGraw Hill, New York.
5. Yeung K W, 2005 Concepts and techniques of GIS, CP Lo Albert, Prentice Hall of India.
6. Misra, R.P. and Ramesh, A. Fundamentals of Cartography, Prasaranga, Manasagangotri, Mysore.

Course Outcomes

- The student will be exposed to the fundamental concepts of remote sensing and GIS
- They will gain knowledge on the Geospatial software and hardware.
- They know the technique of acquisition of spatial data by the use of GPS.

Outcome Mapping

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

Semester-VI | **19IGYT63: Mineral Beneficiation (Department of Chemical Engineering)** | **Credits: 4 Hours:**

Learning Objective (LO):

- To know the various methods of beneficiation of ore minerals.
- To gain knowledge about the methods of grinding, crushing, and separation of minerals.

Unit-1

General principles-Ores, ore types and properties-Scope of ore dressing. A description study of the following Unit operations: Size reduction: Fundamentals-Methods-Preliminary breaking-Jaw crushers-Different types-Jaw and Gyratory crushers-Comparison of disintegrators-Rolls, steam stamps, gravity stamps and stamping.

Unit-2

Fine grinding, wet grinding, Mechanism of tumbling mills,Rod mills, Ball mills and tube mills, Grinding pan. Dry grinding: Buhr and attrition mills, Impact mills, Jet pulveriser, Roller mills. Tube mills, Compartment mill operation. Closed and open Circuit grinding, Modern equipment. Laws of crushing and work index.

Unit-3

Size separation, screening, sizing by screens-Principles of screening-sizing-sieve scale-limits of screening-screening surfaces-types of screens-grizzlies, trammels, revolving shaking and vibrating screens and sampling. Air sizing and dust collection: Principles of suspension in air-Gravitational separators-Internal separators-filters-washers-Electrical precipitation-Dust collecting system.

Unit-4

Classifiers: Principles of settling, free settling, hindred settling-Hydraulic classifiers-Hydroseperators-Mechanical classifiers, types, construction and operation-Gravity concentration-jigging and shaking tables-Wilfley tables-Sink float seperation-Film fixing-pneumatic concentration.

Unit-5

Concentration floatation: Definition-Principle and application for the formation, conditioning. Frothing agents and their action-collecting agents and their action-Pulp control reagents-Dispersing agents-Deflocculators and protective colloids-Floatation meachines-Operation flow sheets-performances-Floatation practice. Electrical concentration: Magnetic separation and concentration-Drum separators-Pully separators-Ball separators-Wet magnetic separation-Magnetic flocculation and deflocculation-Principles of Electrostatic separation-Electrostatic separators.

Books for study:

1. Gaudin, A.M.1984, Principles of Mineral dressing, , Mc Graw Hill Book Co.,
2. Parbin Singh, 1997, Engineering and General Geology, S.K.Kataria and sons., Delhi,
3. Richards, R.H. and Lecke, C.E. 1964, Text Book of ore-dressing, McGraw Hill Book Co.,
4. Truscott, S.J.1954, Text book of ore-dressing, , Macmillan Co.,

Reference Books / Supplementary reading:

1. Gilchrist , 1967, Extractive Metallurgy, Wiley Eastern, New Delhi,
2. Gilchrist, 1981, Extraction Metallurgy, 2nd Ed. Pergamon press, London,
3. Jain S.K. , 1986, Ore processing, Oxford and IBH publishing Co., pvt. Ltd., New Delhi,
4. Taggart, A. F.1955, Hand book of Mineral dressing, John Wiley and Sons,

Course Outcomes

- Students gain the knowledge about the process by which valuable constituents are separated.
- They will gain knowledge on the different ore processing techniques and equipments.

Outcome Mapping

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

Semester-VI **19IGYT64: Applied Geology** **Credits: 4**
Hours:

Learning Objective (LO):

- To understand the applied aspects of geosciences in the fields of Hydrogeology, geophysics and geochemistry.
- Understand briefly about groundwater occurrences, character of aquifers and controls of groundwater.
- To gain knowledge in the different geophysical and geochemical prospecting methods.

Unit-1

Water on earth; Types of water — meteoric, juvenile, magmatic and sea water; Hydrological Cycle and its components; Water-bearing properties of rocks — porosity, permeability, specific yield and specific retention; Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water-bearing properties.

Unit-2

Aquifers; Classification of aquifers; Concepts of drainage basins and groundwater basins; Aquifer parameters- transmisivity and storage coefficient; Fluctuations of water table and piezometric surface; Hydrographs; Springs; Geologic and geomorphic controls on groundwater; Hydrostratigraphic units.

Unit-3

Brief outline on 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, drilling. Sampling errors, precautions against salting. Mineralogical guides: Rock alteration, nature of alteration, target rings of mineral distribution.

Unit-4

Physiographic guides, Stratigraphic and lithological guides: supergene deposits: Reasons for favorability, competent Vs incompetent formations. Structural guides, Fracture pattern as guides: vein patterns. Contacts and folds as guides: Contacts, folds, folds younger than the ore-folds older than ore; dislocated ore bodies.

Unit-5

Principles, chief methods, their applications and limitation. Gravity and Magnetic method, Fundamental principles, field procedures. Specific gravity and magnetic properties of different rocks and minerals. Origin of chemical elements, abundances of elements in the earth crust. Principles of Geochemical cycle. Geochemical Environment and association of elements.

Books for study:

1. Raghunath H.M (2015) Hydrology 3rd ed. New Age International publisher.
2. Todd, D.K. (1980).Groundwater Hydrology, John Wiley and Sons, 2nd Ed.
3. Mason and Moore, 1985, Principles of Geochemistry, Wiley Eastern Ltd. New Delhi,.
4. Parasnis, D.S. 1975. Principles of Applied Geophysics, Chapman and Hall
5. Ramachandran Rao, M.B. 1975, Outlines of Geophysical prospecting (A Manual for Geologists) Presa Ranga, University of Mysore,
6. Stanislane, M. 1984, Introduction to Applied Geophysics, Reidel Publishers
7. Mason, B.1971, Principles of Geochemistry John Wiley & Sons.

Reference Books / Supplementary reading:

1. Dobrin, M.B.1960, Introduction to Geophysical prospecting, ,
2. Govett, G.J.S.(Ed) 1983. Handbook of Exploration Geochemistry, Elsevier
3. Rose,A.W.Hawks,H.E. and Webb,J.A. 1979, Geochemistry in Mineral Exploration, Academic press.
4. Arthur Brownlow 1982, Geochemistry, Prentice Hall,
5. Krauskopf..K.B , 1986, Introduction to geochemistry, , Mc Graw Hill.
6. Sharma,P.V. 1986, Geophysical methods in Geology, Elsevier

Course Outcomes

- The students will gain the knowledge and understand the wide range of applied geosciences concepts.
- The application of geology to mineral exploration, construction of engineering structures and water resource estimation.

Outcome Mapping

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

Semester-VI **19IGYP65: Practical – V Cartography, Aerial Photography, GIS and Mineral Dressing (Engg. Dept)** **Credits: 6 Hours:**

Learning Objective (LO):

- To interpret the geological features, lithology, drainage patterns, engineering structures by using aerial photographs and Satellite products.
- To know the application of different GIS software in hydrogeology, engineering geology and environmental geology.
- To know the techniques of different instruments, apparatus used for the beneficiation of ore minerals, grinding, crushing, filtering and methods of separation of minerals.

CARTOGRAPHY, GPS AND GIS

1. **Cartography**
    a. Scales – Graphical construction of Plain and Diagonal Scale
    b. Map Projection – Construction of Cylindrical, Conical and Zenithal Projection
    c. Topographical Map - Appreciation of Cartographic techniques in SOI sheets
2. **GPS**
    a. Basic Operations and setting up of GPS
    b. Collection of way points and Tracks

3. **GIS Practical**
    a. Conversion Coordinates
    b. Registration and Digitization
    c. Labeling and Annotation
    d. Projection and transformation
    e. Generation of Grid Map

AERIAL / SATELLITE DATA

1. **Aerial photo interpretation**
    a. Annotations of Aerial Photographs
    b. Interpretation keys
    c. Marginal Information
    d. Stereo vision test.
    e. Determination of Flight direction
    f. Determination of photo scale
    g. Tracing details from stereogram and stereo pairs after basic interpretation.
    h. Interpretations of relief, lithology, land use, and vegetation.

2. **Satellite imagery interpretation**
    a. Interpretation keys
    b. Marginal Information
    c. Interpretations of relief, lithology, land use, and vegetation.

MINERAL DRESSING:

- Crushing and grinding
- Tests-Sieve analysis
- Air apparatus-Elutriation-Hydraulic classifiers-Wilfley tables-
- Flotation methods of separation-settling tests, sink and float-Filters and driers.

Course Outcomes

- The students will know the technique of map preparation, attributes addition

- Students will have the field experience on use of GPS.
- They will gain knowledge of the application of different GIS softwares in the lab.
- They will have experience on the mineral processing methods.

Outcome Mapping

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

Semester-VII **19IGYT71: Structural Geology, Geomorphology and Tectonics** **Credits: 4**
Hours:

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

- 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-VII **19IGYT72: Mineralogy and Mineral Optics** **Credits: 4**
Hours:

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, John 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

- 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-VII **19IGYT73: Indian Stratigraphy and Marine Geology** **Credits: 4**
Hours:

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

- 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-VII **19IGYP74: Practical – VI Structural Geology, Mineralogy And Mineral Optics** **Credits: 6 Hours:**

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								✓				

Semester-VIII **19IGYT81: Economic Geology, Mining Geology and Ore Genesis** **Credits: 4**
Hours:

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-VIII **19IGYT82: Coal and Petroleum Geology** **Credits: 4**
Hours:

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-VIII **19IGYT83: Remote Sensing and GIS** **Credits: 4**
Hours:

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											✓	

Semester-VIII **19IGYP84: PRACTICAL – VII Economic Geology, Ore Petrology and Remote Sensing & GIS and Survey** **Credits: 6 Hours:**

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-IX **19IGYT91: Igneous and Metamorphic Petrology** **Credits: 4**
Hours:

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-IX **19IGYT92: Sedimentology And Micropaleontology** **Credits: 4**
Hours:

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-IX **19IGYT93: Atmospheric Sciences** **Credits: 4**
Hours:

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				✓	✓							✓

Semester-IX **19IGYP94: Practical – VIII Petrology, Sedimentology and Micropaleontology and Geological Mapping Report** **Credits: 6 Hours:**

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-X **19IGYT101: Geophysical Explorations** **Credits: 4**
Hours:

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-X **19IGYT102: Geological and Geochemical Explorations** **Credits: 4**
Hours:

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												

Semester-X **19IGYT103: Hydrogeology and Engineering Geology** **Credits: 4**
Hours:

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-X **19IGYP104: Practical – IX Geophysics, Geochemistry, Hydrogeology and Engineering Geology. Mining Industry visit report** **Credits: 6 Hours:**

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.

Outcome Mapping

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

Semester-X **19IGYP105: Project Work Dissertation & Viva-Voce** **Credits: 6**
Hours:

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

19 IGYE 16.1 Fundamentals of Geology
(Elective-I)

Semester- I **Credits:3**
Hours:3

Learning Objective (LO):

- To understand the geology subjects and its importance.
- To know the linkage of geology with other branches.

Unit-1
Geology – definition – Scope and importance, Physical and historical geology, Branches of geology, Geology as interdisciplinary science.
Unit-2
About Structural geology – Definition – Scope and importance. Process and features, Definition of stratigraphy – Scope and objectives of stratigraphy – stratification process of rocks and sediments.
Unit-3
Paleontology – definition – scope and importance. Sub-disciplines of palaeontology.
Geomorphology – definition – scope and importance.
Unit-4
Mineralogy – definition – minerals – scope and importance. Crystallography – definition and scope.
Petrology – definition – scope and importance. Nature of Igneous, Sedimentary and Metamorphic petrology.
Unit-5
Economic geology – concept – scope and importance. Mining geology – scope and importance – role of geologists in mining and mineral economics.

Books for study:

1. Ashit Baran Roy,2010. Fundamentals of Geology. Alpha Science International Limited, United Kingdom.
2. G.B Mahapatra, 2017. A Text Book of Geology. New Age International(p) Ltd, Publisher, India#

Reference Books / Supplementary reading:

1. P.K. Mukherejee, 1987. A Text Book of Geology, Kolkata.
2. Suboth Dhakal, 2012, Fundamentals of Geology, Kalyani Subedi, Nepal.

Course Outcomes

- Students able to understand the basis of the subject
- Understand the different components to study in the course
- Understand the branches of geology

Outcome Mapping

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

19 IGYE 16.2 Physics and Chemistry of the Earth
(Elective-I)

Semester- I **Credits:3**
Hours:3

Learning Objective (LO):

- To understand the earth and its importance.
- To know the distribution of elements.

Unit-1
Earth: surface features Continents, continental margins, oceans

Unit-2
Earth's interior Variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities. Concepts of Isostasy; Airy and Pratt Model. Core: Seismological and other geophysical constraints. The geodynamo – convection in the mantle.

Unit-3
Elements of earth's magnetism Secular variation and westward drift; Solar activity and magnetic disturbance.

Unit-4
Elements Origin of elements. Abundance of the elements in the solar system / planet earth; Earth accretion and early differentiation; Stable isotopes: Different isotopes and its geological applications.

Unit-5
Environmental geochemistry Geological disposal of nuclear waste; Lead in environment and effect of lead on human health

Books for study:

1. Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
2. Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
3. Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill

Reference Books / Supplementary reading:

1. Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
2. Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
3. Steiner, E. (2008). The chemistry maths book. Oxford University Press.
4. Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press

Course Outcomes

- Students able to understand the basis of the subject
- Understand the different physical and chemical components of earth.
- Understand the environmental geochemistry.

Outcome Mapping

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

CO3			✓			✓				✓	✓	

19 IGYE 36.1 Fundamentals of Applied Geology
(Elective-II)

Semester- III **Credits:3**
Hours:3

Learning Objective (LO):

- To understand the applied geology subjects and its importance.
- To know the linkage of applied geology with other branches.

Unit-1
Geology and applied geology- Scope and importance of applied geology- Relation with other branches of sciences

Unit-2
Applied hydrogeology- concept- scope and importance- relation with other branches of hydrogeology.

Unit-3
Applied sedimentology- definition- scope and importance- relation with other branches of petrology, environment and stratigraphy.

Unit-4
Geophysics- definition- scope and application, Geochemistry- definition- scope and applications. Relationship with other branches.

Unit-5
Engineering geology- application with engineering projects. Mining geology, Environmental geology- concept, scope and role of geologist.

Books for study:

1. Sanjay Akhauri, 2015, Fundamentals of Hydrogeology, Zobra Books.
2. Bernard K Rop, Wycliffe H Namwiba, 2018 Fundamentals of Applied Geology Competency and Evaluation Approach, LAP LAMBERT Acdemic Publishing, Germany.
3. D.V. Reddy, 2018 Applied Geology, I Edn.Vikas Publishing House Pvt. Ltd.
4. G.B.Mahapatra, 2017. A text book of Geology, New Age International (P) Ltd. Publishers India.

Reference Books / Supplementary reading:

1. P.K.Mukherejee, 1987 A text book of Geology, Kolkata.
2. Suboth Dhakal, 2012 Fundamentals of Geology, Kalyani Subedi, Nepal.

Course Outcomes

- Students able to understand the basis of the subject
- Understand the different branches of applied geology.
- Understand the relationship and importance of studying applied geology

Outcome Mapping

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

19 IGYE 36.2 Geo-Heritage and Geo-Tourism (Elective-II)

Semester- III **Credits:3**
Hours:3

Learning Objective (LO):

- To understand the importance of Geological heritage and locations of geological sites
- To know the geo-tourism and importance of field visits of geological sites.

Unit-1
Introduction to Heritage- Geodiversity-Geoheritage. Defintion and introduction to Geotourism. Geoconservation. Importance of studying Geological heritage. Geoheritage site- meaning, Distribution in Tamil Nadu.

Unit-2
Geoheritage sites in Tamil Nadu- detailed study on their location, Geology, conservation and their important features- Fossil wood near Tiruvakkarai, National fossil wood park Sattanur, Charnockite St. Thomas Mount, Badlands of Karai- Kulakkalnatham.

Unit-3
Geoheritage sites in South India- detailed study on their location, Geology conservation and their important features- Peninsular gneiss, Lalbagh Botanical Garden; Columnar Basalt, Coconut Island; Pillow lavas, Chitradurga District; Pyroclastic rocks Kolar district. Varkala cliff section, Thiruvananthapuram; Volcanogenic bedded barytes, Cuddapah; Eparchaean Unconformity, Chittor;

Unit- 4
Geoheritage sites in other than South India- detailed study on their location, Geology, conservation and their important features- Stromatolite Fossil park, Jamarkotra; Akal Fossil Wood park, Jaisalmar; Plant fossil bearing Inter-trappean beds of Rajmahal Formation; Lonar Lake, Buldana Dist. Maharashtra.

Unit-5
Recognition of Geological and Geomorphological heritage in India. Importance of Geology and geography in tourism, natural and climatic regions of India. Important places of attraction for geological sites.

Books for Study:

1. Geological world heritage: A global framework- paul Dingwall, Tony Weighell and Tim Badman (2005)
2. A monograph on National Geoheritage monuments of India (2016)- INTACH, Natural Heritage division, New Delhi.

Reference Books / Supplementary reading:

1. Tourism Geography (1998) Philip.G. National Publisher

Course Outcomes:

- Students gain knowledge on geological importance of the various places.
- Students understand the importance of field visit of geological monuments.

Outcome Mapping

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

19 IGYE 56.1 Introduction to Geological Software
(Elective-III)

Semester-V **Credits:3**
Hours:3

Learning Objective (LO):

- Understand the computer software for geological studies.
- To understand applications of the softwares used in the interpretation of the geological data

Unit-1
Interpretation and analysis of Geological data using MS- office, IGPET, WATEQ4F

Unit-2
Applications, Principles of data input, processing, interpretation in software like PHREEQC and MODFLOW

Unit-3
ARCGIS, Mapinfo for spatial analysis and integration of complex geological and geophysical data. ERDAS IMAGINE as image-processing tools for analyzing remotely sensed data.

Unit-4
Overview of geostatistical analysis using statistical package SPSS, Graphical analytical packages like Surfer and RockWorks for both 2-D surfaces.

Unit-5
Data Interpretation: Toposheets, Aerial photographs, Satellite imageries. Interpretation of Meteorology data: rainfall, temperature, wind, humidity; Interpretation of borehole logs, litho log, SP log, Resistivity log, Gamma log, neutron log.

Books for Study:

1. Wen-Hsing Chaing & Wolgang Kinzelbach "User Manual for Processing MODFLOW", windows version 4.0,1996.
2. Sharon L. Qi, Jennifer B. Sieverling using ArcInfo to facilitate numerical modeling of ground – water flow,1997.
3. Hill Mc(1992) MODFLOW – A computer program for estimating parameters of a transient, 3-D, Ground flow model using non linear regression, U.S. Geological Survey, open-file report – 91-484.

Reference Books / Supplementary reading:

1. ERDAS: IMAGE 2018, Version 16.5(V 16.5.0.82)
2. PHREEQC Ver.1: Ground water & pollution, II Edition: A.A. Balkana. Publication, Leiden. The Parkhurst,D.L.,1995,user's guide to PHREEQC.

Course Outcome:

- Gain the knowledge of computer softwares in geology
- Gain the knowledge of applications and interpretation of computer software.

Outcome Mapping

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

19 IGYE 56.2 Natural Resources
(Elective-III)

Semester-V **Credits:3**
Hours:3

Learning Objective (LO):

- To understand the sources on the earth.
- To know the types of natural resources.
- To know about importance of studying natural resources.

Unit-1

Forest resources- Types of forest- uses of forests.

Unit-2

Water Resources- Surface water- Ground water ad wells- floods- water pollution and quality- water borne diseases.

Unit-3

Mineral resources- brief outline of metallic minerals- Atomic minerals.

Unit-4

Food resources- World food Problem- uneven distribution of food- changes caused by agriculture- Fertilizers- Pesticides.

Unit-5

Energy resources- Energy demands- Renewable energy resources- non renewable energy resources- atomic energy.

Books for Study:

1. Anji Reddy. M (2012).Text of Environmental Sciences,B.S.Publications, Hyderabad.
2. Daniel R. Lynch (2009).Sustainable Natural resource Management; for Scientists and Engineers. Cambridge University Press.
3. Kevin H. Deal. (2011) Wildlife and natural Resource Management, 3rd edition. Delmar Cengage.

Reference Books / Supplementary reading:

1. Graham Park(2016). Introducing Natural Resources, Dunedin Academic.
2. Pandey.B.W. (2005). Natural Resource Management. Mittal Publications

Course Outcome:

- Gain the knowledge of natural resources on the earth.
- Gain the knowledge of distribution and management of resources.

Outcome Mapping

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

Semester-VIII **19IGYE85.1: Environmental Geosciences & Disaster Management** **Credits: 3**
Hours: 3

(Elective-IV)

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-VIII | **19IGYE85.2: Medical Geology (Elective-IV)** | **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-IX **19IGYE95.1: Instrumentation and Analytical Techniques** **Credits: 3**
Hours: 3

(Elective-V)

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-IX **19IGYE95.2: Environmental Isotopes in Groundwater Hydrology** **Credits: 3**
Hours: 3

(Elective-V)

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	✓					✓						

INTERDEPARTMENTAL ELECTIVE COURSES

Semester-VIII **19IGYE86.1: 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-IX | **19IGYE96.1: 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			✓								✓	