ANNAMALAI UNIVERSITY

FACULTY OF SCIENCE

DEPARTMENT OF EARTH SCIENCES

M. Sc. GEOLOGY
(2 Year Programme)

COURSE CODE: SEAR21

HAND BOOK
1. Name of the Programme:

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

2. Eligibility for Admission:

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

3. Duration of the programme:

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

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

4. Course Features:

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

5. Grading System:

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

6. Structure of the Programme:

The Masters Programme will consist of:

i. Core courses which are compulsory for all students.

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

iii. Dissertation / Project Work / Practical training / Field work, which can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.
7. Attendance:

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

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

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

8. Examinations:

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

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

<table>
<thead>
<tr>
<th>Theory</th>
<th>Internal Marks</th>
<th>Practical</th>
<th>Internal Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test-I</td>
<td>15</td>
<td>Test-I</td>
<td>15</td>
</tr>
<tr>
<td>Test-II</td>
<td></td>
<td>Test-II</td>
<td>15</td>
</tr>
<tr>
<td>Seminar and Assignment</td>
<td>10</td>
<td>Record</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

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

9. Evaluation of dissertation:

The dissertation shall be evaluated as follows

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

10. Marks and Grading:

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

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

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

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

11. Grading:

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme.
<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade Points</th>
<th>Letter Grade</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 and above</td>
<td>10</td>
<td>S</td>
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<tr>
<td>85-89</td>
<td>9.0</td>
<td>D+++</td>
<td>Distinction</td>
</tr>
<tr>
<td>80-84</td>
<td>8.5</td>
<td>D++</td>
<td>Distinction</td>
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<tr>
<td>75-79</td>
<td>8.0</td>
<td>D+</td>
<td>Distinction</td>
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<tr>
<td>70-74</td>
<td>7.5</td>
<td>A+++</td>
<td>First Class</td>
</tr>
<tr>
<td>65-69</td>
<td>7.0</td>
<td>A++</td>
<td>First Class</td>
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<td>60-64</td>
<td>6.5</td>
<td>A+</td>
<td>First Class</td>
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<tr>
<td>55-59</td>
<td>6.0</td>
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<td>50-54</td>
<td>5.5</td>
<td>C</td>
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<td>49 or Less</td>
<td>RA</td>
<td>Reappear</td>
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</table>

The successful candidates are classified as follows.

I – Class 60% marks and above in overall percentage of marks (OPM).
II – Class 50-59% marks in overall percentage of marks.

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

12. Course-Wise Letter Grades:

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

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

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

If a student secures RA grade in the Project Work / Field Work / Practical Work / Dissertation, he/she shall improve it and resubmit if it involves only rewriting by incorporating the clarifications as per the suggestions of the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.
Annamalai University
Department of Earth Sciences
M.Sc. Geology (Two Year) Programme
Programme Code: SEAR21
Programme Structure
(For students admitted from the academic year 2019-2020)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours/Week</th>
<th>Marks</th>
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**Semester-I**

<table>
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<th>Hours/Week</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>19GEO101</td>
<td>Core 1: Structural geology, Geomorphology &amp; Tectonics</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO102</td>
<td>Core 2: Mineralogy and Mineral Optics</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO103</td>
<td>Core 3: Indian Stratigraphy and Marine Geology</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO104</td>
<td>Core 4: Practical I Structural Geology, Mineralogy and Mineral optics</td>
<td>12 6 40</td>
<td>60 100</td>
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<tr>
<td>Elective 1: Interdepartmental Elective</td>
<td>3 3 25</td>
<td>75 100</td>
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**Semester-II**

<table>
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</thead>
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<tr>
<td>19GEO201</td>
<td>Core 5: Economic Geology, Mining Geology and Ore Genesis</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO202</td>
<td>Core 6: Coal and Petroleum Geology</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO203</td>
<td>Core 7: Remote Sensing and GIS</td>
<td>4 4 25</td>
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<tr>
<td>19GEOP204</td>
<td>Core 8: Practical II Economic Geology, Ore petrology and Remote Sensing &amp; GIS and Survey</td>
<td>12 6 40</td>
<td>60 100</td>
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<tr>
<td>Elective 2: Interdepartmental Elective</td>
<td>3 3 25</td>
<td>75 100</td>
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<td>Elective 3: Department Elective</td>
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**Semester-III**

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<tr>
<td>19GEO301</td>
<td>Core 9: Igneous and Metamorphic Petrology</td>
<td>4 4 25</td>
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<tr>
<td>19GEO302</td>
<td>Core 10: Sedimentology and Micropaleontology</td>
<td>4 4 25</td>
<td>75 100</td>
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<tr>
<td>19GEO303</td>
<td>Core 11: Atmospheric Sciences</td>
<td>4 4 25</td>
<td>75 100</td>
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<td>19GEOP304</td>
<td>Core 12: Practical III Petrology, Sedimentology and Micropaleontology and Geological mapping report.</td>
<td>12 6 40</td>
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<td>Elective 4: Interdepartmental Elective</td>
<td>3 3 25</td>
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<td>Elective 5: Department Elective</td>
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**Semester-IV**

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<tr>
<td>19GEO401</td>
<td>Core 13: Geophysical Exploration</td>
<td>4 4 25</td>
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<tr>
<td>19GEO402</td>
<td>Core 14: Geological and Geochemical Exploration</td>
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<td>75 100</td>
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<tr>
<td>19GEO403</td>
<td>Core 15: Hydrogeology and Engineering Geology</td>
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<td>75 100</td>
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<tr>
<td>19GEOP404</td>
<td>Core 16: Practical IV Geophysics, Geochemistry, Hydrogeology and Engineering Geology. Mining industry visit report.</td>
<td>12 6 40</td>
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<tr>
<td>19GEOP405</td>
<td>Project work Dissertation Viva-voce</td>
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</table>

**Total Credits**

93

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

### Interdepartmental Electives (IDE)

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

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours/week</th>
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<th>Marks</th>
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<tbody>
<tr>
<td>1.</td>
<td>19GEOE205.1</td>
<td>Environmental geosciences and disaster management</td>
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<td>2.</td>
<td>19GEOE205.2</td>
<td>Medical Geology</td>
<td>3 3</td>
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<tr>
<td>3.</td>
<td>19GEOE305.1</td>
<td>Instrumentation and Analytical Techniques</td>
<td>3 3</td>
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<td>4.</td>
<td>19GEOE305.2</td>
<td>Environmental Isotopes in Groundwater hydrology</td>
<td>3 3</td>
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<td>25 75 100</td>
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</tbody>
</table>
PROGRAMME OUTCOMES (POs)

PO1 The programme in Geology will provide in depth knowledge in the field of earth science to the students.

PO2 The students will be capable of appreciating the existence and exploration of natural resource system.

PO3 Makes the students fully competent to undertake any job in the field of Geology.

PO4 Promotes interest of the student to take up higher studies in field of earth sciences.

PO5 Students will be fully aware of the earth environment and responsible for the management of environment.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

PSO1 Gains complete knowledge about all fundamentals of Geoscience branches.

PSO2 Understand the basic concepts on the earth structures, tectonics, morphology.

PSO3 Understand the mineral structures, chemistry of minerals and their formation. Rocks types their origin, classification and importance.

PSO4 Gains the knowledge on the distribution of various metallic and non metallic ores, economic importance, their genesis, and their distribution.

PSO5 Understand the origin and occurrence of petroliferous and coaliferous basins of India.

PSO6 Capable of doing exploration for mineral resources using, geological, geophysical, geochemical and remote sensing techniques.

PSO7 Gains the knowledge on the atmosphere, climate and its impact on earth.
Learning Objective (LO):

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

Unit-1

Unit-2

Unit-3

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

Books for study:

Reference Books / Supplementary reading:

Course Outcomes
At the end of the course, the student will be able to
- Students will gain the knowledge over mechanical properties of rocks.
• Students will able to understand the petrofabric and structural analysis of rocks.
• Understand the concept of geomorphology, processes and landforms.
• Understand the application of geomorphology and theories of paleomagnetism.
• Students understand the concept of plate tectonics and theory.

**Outcome Mapping**

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
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**Semester-I**

19GEO102: Mineralogy and Mineral Optics  
**Credits:** 4  
**Hours:** 4

**Learning Objective (LO):**

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

**Unit-1**

**Unit-2**

**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**

**Books for study**
1. Buerger, M.J.1956 Elements of Crystallography, Jophn Wiley and sons,
2. Dana, E.S.1935 A Text Book of Mineralogy, John Wiley & Sons,
3. Ernest, E.Walhstrom, 1960, Optional Crystallography, John Wiley & Sons,
Reference Books / Supplementary reading:

1. American mineralogist special volumes on Mineralogy.

Course Outcomes

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

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

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Semester-I

19GEO103: Indian Stratigraphy and Marine Geology  Credits: 4  Hours: 4

Learning Objective (LO):

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

Unit-1

Methods of stratigraphic 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

Unit-4

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:

Reference Books / Supplementary reading:

Course Outcomes
At the end of the course, the student will be able to
- Students will acquire knowledge on distribution of rock types and their formation at different ages.
- Understanding the ocean morphology and formation along with mineral resources of marine environment are known.

Outcome Mapping

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Semester-I  

19GEOP104: Structural Geology, Mineralogy and Mineral Optics  

Credits: 6  
Hours: 12  

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

Structural Geology:  
Elementary structural analysis with use of stereographic methods  

Mineralogy & Mineral Optics:  

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.  
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.  

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.  

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12
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

Unit-2

Unit-3

Unit-4

Unit-5

Books for study:

Reference Books / Supplementary reading:
1. Mc Kinstry, H.E. (1960). Mining Geology, Asia publishing house,

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

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

Learning Objective (LO):

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

Unit-1  

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  

Unit-4  

Unit-5  

Books for study:
2. Levorson, A.L. Vakils, (1972), Geology of Petroleum, Peter and Simon Limited, Bombay,
3. Moore, E.S. (1980). Coal, John Wiley & Sons,

Reference Books / Supplementary reading:
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

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Semester-II

19GEO203: Remote Sensing and GIS

Credits: 4
Hours: 4

Learning Objective (LO):

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

Unit-1


Unit-2


Unit-3

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

Unit-4

Unit-5

Books for study :

Reference Books / Supplementary reading:

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.

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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
   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.

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Semester-III 19GEO301: Igneous and Metamorphic Petrology

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

Unit-2
Petrography of igneous rocks- Petrography and petrogenesis of Granites, Pegmatites, Alkaline rocks, Mono-mineralic rocks. Anorthosites and Dunites, Lamprophyres, Carbonatites, Charnockites and Ultramafics.

Unit-3

Unit-4

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:

Reference Books / Supplementary reading:

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

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Semester-III

19GEO302: Sedimentology and Micropaleontology

Credits: 4
Hours: 4

Learning Objective (LO):

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

Unit-1

Unit-2

Unit-3

Unit-4

Unit-5

Books for study:


Reference Books / Supplementary reading:


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.

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Semester-III

19GEO303: Atmospheric Sciences

Credits: 4
Hours: 4

Learning Objective (LO):

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

Unit-1

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

Books for study:

Reference Books / Supplementary reading:

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

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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 - Megasopic and Microscopic identification - Texture, Structure and Petrogenesis.

**Igneous Rocks:**
1. Charnockite, Granite, Rhyolite and Dacite
2. Syenite, Nepheline 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.

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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

Unit-2

Unit-3

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:

Reference Books / Supplementary reading:
4. 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.

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Semester-IV

19GEO402: Geological and Geochemical Explorations

Credits: 4

Hours: 4

Learning Objective (LO):

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

Unit-1


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


Unit-4


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:

2. Goldschmidt, V.M.1954, Geochemistry, Oxford University press.
6. Rankama and Sahama, (1950), Geochemistry, University of Chicago Press,

Reference Books / Supplementary reading:

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.

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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

Unit-5

Books for study:
1. Davie and De Weist, (1965), Hydrology, John Wiley and Sons.

Reference Books / Supplementary reading:
4. Rogar, J.M. Deweist, (1965), Geohydrology John wiley and sons,
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.

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Semester-IV 19GEOP404: Practical – IV Geophysics, Geochemistry, Hydrogeology and Engineering Geology

Credits: 6
Hours: 12

Learning Objective (LO):

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

GEOPHYSICS:

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

GEOCHEMISTRY:

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

HYDROGEOLOGY:

i. Calculation of Rainfall by Arithmetic 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.
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.

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Semester-IV

19GEO405: Project Work Dissertation & Viva-Voce

Credits: 6
Hours: 12

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

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

COURSE CODE: 19 GEOE 205.1

Course Title: ENVIRONMENTAL GEOSCIENCES & DISASTER MANAGEMENT

Semester- II

Credits: 3
Hours : 3

Learning Objective (LO):
- To understand the principles of environmental geology.
- To know the types of Environmental hazards & disasters.
- To know about the emerging approaches in Disaster Reduction & Management.

UNIT-1

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**

**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:**

**Reference Books / Supplementary reading:**

**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.

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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

Unit-3

Unit-4

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:

Reference Books / Supplementary reading:
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.

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Semester-III

19GEOE305.1: Instrumentation and Analytical Techniques  
Credits: 3  
Hours: 3

Learning Objective (LO):
- To Focus on instrumentation and analytical techniques for various geological applications.
- To know about the different geological techniques for sample analysis.
- To understand the analytical techniques using various instruments.

Unit-1
Rock sample collection, sediment sample collection, water sample collection, samples for geochemical study. Collection of samples from exposed materials. Sampling apparatus-Scraper or drag bucket type of sampler, coring tube samplers, Snapper or grab bucket samplers, Rod samplers.

Unit-2

Unit-3

Unit-4

Unit-5

Books for study:
Reference Books / Supplementary reading:

2. Putnis, Andrew, 1992, Introduction to Mineral Sciences, , Cambride University press,

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

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Semester-III

19GEOE305.2: Environmental Isotopes In Groundwater Hydrology

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 $^{18}\text{O}/^{16}\text{O}$ and $^{2}\text{H}/^{1}\text{H}$ 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 - $^{14}\text{C}$ standard - natural $^{14}\text{C}$ variations - $^{14}\text{C}$ age determination - Palaeoclimate reconstruction. Groundwater salinization in coastal aquifers.
Books for study:
   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.

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Semester-II

19GEOE215.1: Environmental Geosciences
Credits: 3
Hours: 3

Learning Objective (LO):
- Aim to study the various components of Atmosphere.
- To understand the energy sources.
- To understand the various natural and manmade hazards.
- To understand the water and air qualities and its issues.
- To understand the environmental management policies.

Unit-1
Components of Environment, Atmosphere, hydrosphere, lithosphere, biosphere, their interactions and related problems. Renewable and nonrenewable resources - types of alternative renewable energy sources - their advantages.

Unit-2

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

Unit-5

Books for study:

Reference Books / Supplementary reading:
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.

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

Learning Objective (LO):
- Illustrating the new frontiers of geosciences as a tool for various exploration.
- To understand the basic principles of geophysical explorations.
- To understand the basic methods of geophysical explorations.
- To understand the radioactive and earth’s magnetic field for exploration.
Unit-1
The earth and the solar system-important basic physical and chemical properties of the planet earth. Description and identification of important rock forming minerals-Physical & Optical. Description and identification of important rock types.

Unit-2

Unit-3

Unit-4
Gravity methods-Principles and application of gravity method. Radioactivity-Principles, applications and instruments-Exploration of radioactive minerals.

Unit-5

Books for study:

Reference Books / Supplementary reading:
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.

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