Curriculum and Credit Framework

**of**

Four Year Undergraduate Programme
(FYUGP)

**in**

# GEOLOGY UNDER NEP

**for**

**St. Xavier's College, Ranchi**
**(An Autonomous College of Ranchi University)**

**w.e.f. Academic Session 2025 - 2029**

# Department of Geology
## St. Xavier's College
## Dr. Camil Bulcke Path, Ranchi - 834001

**Meeting of Board of Studies – Geology (B. Sc.; M. Sc.)**
**Venue: Department of Geology, St. Xavier's College, Ranchi**

Date: 04.11.2025

Honourable Members Present:

| Sl. No. | Members | | Signature |
|---|---|---|---|
| 1. | **Ms. Mable M. Toppo**<br>Head, Department of Geology<br>St. Xavier's College, Ranchi | Chairperson | 04/11/25 |
| 2. | **Prof. (Dr.) Uday Kumar**<br>Ex. Head, Univ. Dept. of Geology<br>Ranchi University, Ranchi | University Representative | 4.11.25 |
| 3. | **Prof. (Dr.) A.P. Krishna**<br>Department of Remote Sensing,<br>BIT, Mesra, Ranchi | External Member and Subject Expert | 4/11/25 |
| 4. | **Prof. (Dr.) Sahendra Singh**<br>Department of Applied Geology,<br>IIT-I.S.M., Dhanbad | External Member and Subject Expert | 04.11.25 |
| 5. | **Dr. M. K. Saini**<br>Senior Principal Scientist<br>CSIR – CIMFR, Ranchi | Expert from Industry | 04/11/2025 |
| 6. | **Shri Atul Beck**<br>Scientist – B,<br>CGWB, SUO, Ranchi | Alumnus Member | Beck 4-11-25 |
| 7. | **Mr. Vinod Kumar Tirkey**<br>Department of Geology<br>St. Xavier's College, Ranchi | Internal Member | 4.11.25 |
| 8. | **Dr. Somesh Sengupta**<br>Department of Geology<br>St. Xavier's College, Ranchi | Internal Member | 4/11/25 |
| 9. | **Dr. Melvin A. Ekka**<br>Department of Geology<br>St. Xavier's College, Ranchi | Internal Member | 4/11/2025 |

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## *HIGHLIGHTS OF FYUGP CURRICULUM*

### *PROGRAMME DURATION*

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from 1st of July.

### *ELIGIBILITY*

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if Marks of the Major subject is not available. Reservation norms of The Government of Jharkhand must be followed as amended in times.
- UG Degree Programmes with Double Major shall be provided only to those students who secure a minimum of overall 75% marks (7.5 CGPA) or higher.
- Other eligibility criteria including those for multiple entry will be considering the UGC Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions.

### *ADMISSION PROCEDURE*

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the college / University for FYUGP.

### *VALIDITY OF REGISTRATION*

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

***ACADEMIC CALENDAR***

- An Academic Calendar will be prepared by the university to maintain uniformity in the CBCS of the UG Honours Programmes, UG Programmes, semesters and courses in the college run under the university (Constituent/Affiliated).
- Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.
- Semester: The Odd Semester is scheduled from July to December, and the Even Semester is from

January to June. Each week has a minimum of 40 working hours spread over 6 days.

- Each semester will include – Admission, course work, conduct of examination and declaration of results including semester break.
- To undergo 8 weeks' summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:

  a) *Odd Semester: From first Monday of August to third Saturday of December*

  b) Even Semester: From first Monday of January to third Saturday of May

- An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week, this would mean that each semester will have 90/ 6 = 15 teaching/ working weeks. Each working week will have 40 hours of instructional.

***PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME***

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
  - UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/ Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.,
  - UG Diploma after 2 years (4 semesters) of study diploma provided they complete one vocational course of 4 credits or internship/ Apprenticeship/ skill based vocational

courses offered during first year or second year summer term in addition to 9 credits from skill-based courses earned during first, second, and third semester,

- Bachelor's Degree after a 3-year (6 semesters) programme of study,
- Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study.
- Bachelor's degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking 12 credit Research component in fourth year of FYUGP.

**CREDIT OF COURSES**

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.

   **One credit for Theory** = 15 Hours of Teaching i.e., 15 Credit Hours

   **One credit for Practical** = 30 Hours of Practical work i.e., 30 Credit Hours

b) For credit determination, instruction is divided into three major components:

   **Hours (L)** – Classroom Hours of one-hour duration.

   **Tutorials (T)** – Special, elaborate instructions on specific topics of one-hour duration

   **Practical (P)** – Laboratory or field exercises in which the student must do experiments or other practical work of two-hour duration.



**CHANGE OF MAJOR OR MINOR COURSES**

The change of Major or Minor courses may be allowed only once after the Second Semester and before the third Semester in the FYUG Programme, depending on the provisions laid by the FYUGP and the conditions laid by the Institution. **However, the student must clear the papers (Mid Sem & End Sem both) from the previous semesters of the new subject opted in the next Examination of the coming session.**

## CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

## PROMOTION CRITERIA

**First degree programme with a single major (160+4=164 credits):**

The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.

No student will be detained in odd Semesters (I, III, V & VII).

To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student has to pass in minimum 11 papers out of the total 14 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 4 papers out of 7 papers in Semester-II.

To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum of 20 papers out of the total 26 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 6 papers in Semester-IV.

To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum of 27 papers out of the total 36 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student has to pass in 3 papers out of 5 papers in Semester VI.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

**First degree programme with dual major (192+4=196 credits):**

Please refer to the FYUGP Regulations for the detailed provisions of Double Major and Dual Degrees.

No student will be detained in odd Semesters (I, III, V & VII).

To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of the Courses in an academic year, a student must pass in minimum 11 papers out of the total 15 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student must pass in 4 papers out of 8 papers in Semester-II.

To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student must pass in minimum 20 papers out of the total 27 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student must pass in 4 papers out of 7 papers in Semester-IV.

To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student must pass in minimum 28 papers out of the total 37 papers. It is further necessary to procure pass marks in minimum of 50% papers of the current semester i.e. the student must pass in 3 papers out of 6 papers in Semester VI.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

**PUBLICATION OF RESULTS**

- The result of the examination shall be notified by the Controller of Examinations.
- If a student is found indulged in any kind of malpractice/ unfair means during examination, the examination taken by the student for the semester will be cancelled. The candidate must reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.
- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.
- Regulation related with any concern not mentioned above shall be guided by the Regulations of the college / University for FYUGP.

## COURSE STRUCTURE FOR FYUGP **'HONOURS/ RESEARCH/ PG DIPLOMA'**

**Table 1: Credit Framework for Four-Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 164]**

| Academic Level | Level of Courses | Semester | MJ: Discipline Specific Courses – Core or Major (80) | AC: Associated core courses from discipline/ Interdisciplinary/ vocational (8) | | ELC: Elective courses may be opted from four paths [Follow table 2] (24) | MDC: Multidisciplinary Courses (From a pool of Courses) (9) | AEC: Ability Enhancement Courses (Modern Indian Language and English) (8) | SEC: Skill Enhancement Courses (9) | VAC: Value Added Courses (6) | IKS: (i) Indian Knowledge System (2) & SA: (ii) Social awareness (2) | RC: Research Courses (4+8)/ | AMJ: Advanced Courses instead of Research (4+4+4)/ PGD: PG Diploma Level 6 (4+4+4) | Total Credits | IAP; Internship/Apprenticeship/ Project/ Vocational course/ Dissertation (4) In between Sem I to Sem-VI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 (Major- 80) | 4 (Minor-32) | | | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Level 4.5** | Level 100-199: **Foundation or Introductory courses** | **I** | 4 | 4 | --- | --- | 3 | 2 | 3 | 2 | 2 | --- | --- | **20** | |
| | | **II** | 4 | --- | 4 | --- | 3 | 2 | 3 | 2 | 2 | --- | --- | **20** | |
| | | **Exit Point: Undergraduate Certificate provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)** | | | | | | | | | | | | | |
| **Level 5** | Level 200-299: **Intermediate-level courses** | **III** | 4+4 | --- | | 4 | 3 | 2 | 3 | --- | --- | --- | --- | **20** | 4 |
| | | **IV** | 4+4+4 | --- | | 4 | --- | 2 | --- | 2 | --- | --- | --- | **20** | |
| | | **Exit Point: Undergraduate Diploma provided with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)** | | | | | | | | | | | | | |
| **Level 5.5** | Level 300-399: **Higher-level courses** | **V** | 4+4+4+4 | --- | | 4 | --- | --- | --- | --- | --- | --- | --- | **20** | |
| | | **VI** | 4+4+4+4 | --- | | 4 | --- | --- | --- | --- | --- | --- | --- | **20** | |
| | | **Exit Point: Bachelor's Degree with Summer Internship/ Project/ Vocational course/ Dissertation (4 credits)** | | | | | | | | | | | | **124** | |
| **Level 6** | Level 400-499: **Advanced courses** Hons with Research (>7.5 CGPA)/ Honours/ PG Diploma | **VII** | 4+4+4 | --- | | 4 | --- | --- | --- | --- | --- | 4 | 4 | **20** | --- |
| | | **VIII** | 4+4 | --- | | 4 | --- | --- | --- | --- | --- | 8 | 4+4 | **20** | |
| | | **Exit Point: Bachelor's Degree with Honours/ Honours with Research/ PG Diploma Level 6** | | | | | | | | | | | | **164** | |

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project.

Table 2: Options for Elective Minor Courses

| Path A | Path B | Path C | Path D |
|---|---|---|---|
| **ELC-A**; Elective courses from Interdisciplinary Subjects 1 & 2 (24) | **ELC-B**; Elective courses from discipline (24) | **ELC-C**; Elective courses from vocational (24) | **ELC-D**; Elective courses from discipline for Double Major (48) |
| This pathway may be recommended for students who wish to develop core competency in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/subjects.<br><br>If students pursuing FYUGP are awarded a UG Degree in a Major discipline, they are eligible to mention their core competencies in other disciplines of their choice if they have earned 12 credits each from pathway courses of two particular disciplines.<br><br>In the first three years of FYUGP, this pathway is composed of one Major discipline with 60 credits from 15 courses, and two other disciplines, with 12 credits from 3 courses in each discipline.<br><br>In this pathway, if the students choose one of the two disciplines for 12 credits in one discipline then they should choose a different discipline for the other 12 credits.<br><br>If the students continue to the fourth year of FYUGP, the students need to earn an additional 4 credits in both disciplines. | This pathway may be recommended to those students who wish for an in-depth study in more than one discipline with a focus on one discipline (Major) and relatively less focus on the other (Minor).<br><br>If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in another discipline of their choice, if they earn a minimum of 24 credits from the courses in the Minor discipline.<br><br>If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the Minor discipline, to be eligible for a UG Degree (Honours) with a Major and a Minor. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Minor discipline. | This pathway may be recommended to those students who wish for exposure to a vocational discipline in addition to the in-depth study in the Major discipline.<br><br>The credit requirements for Major and Vocational Minor disciplines in this pathway are the same as those for Major with Minor pathway, except that the Minor courses are in a vocational discipline.<br><br>If students exit at the end of the third year of FYUGP, they are awarded a Major Degree in a particular discipline and a Minor in vocational discipline of their choice, if they earn a minimum of 24 credits from the Vocational courses.<br><br>If the students continue to the fourth year of FYUGP, they should earn a minimum of 32 credits in the vocational discipline. For this, in the fourth year, they should earn an additional minimum of 8 credits through 2 courses in the Vocational discipline. | To secure the required minimum credits in each discipline, students who wish to opt for a Double Major should include the credits earned by them from the Multi-Disciplinary Courses, Skill Enhancement Courses, and Value-Added Courses offered by the respective Major disciplines.<br><br>The Double Major pathway is extended to the fourth year. Shifting to a double major from a minor in the third semester will be allowed subject to clearance of the courses of double major (not studied earlier) in succeeding sessions.<br><br>In the fourth year, the student can continue to earn the required credits in either Major A or Major B to qualify for a UG Degree (Honours)/ UG Degree (Honours with Research) in A or B.<br><br>If he/she opts to continue with Major B in the fourth year, he/she should earn an additional 16 credits of 300-399 level in Major B through mandatory online courses. The institution will not provide the courses in physical mode in the fourth year of this segment. |

Table 3: Credit Distribution in Elective Minor Courses during the Four Year of FYUGP

| Academic Level | Level of Courses | Semester | Path A ELC; Elective courses from Interdisciplinary Subjects 1 & 2 (24) | | Path B ELC; Elective courses from the discipline (24) | Path C ELC; Elective courses from vocational (24) | Path D ELC; Elective courses from the discipline for Double Major (64) |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3A. Subject 1 | 3B. Subject 2 | 4 | 5 | 6 |
| **Level 4.5** | Level 100-199: **Foundation or Introductory courses** | **I** | --- | --- | --- | --- | 4+4 |
| | | **II** | --- | --- | --- | --- | 4+4 |
| | | **Exit Point: Bachelor's Degree with Hons. with Research** | | | | | |
| **Level 5** | Level 200-299: **Intermediate-level courses** | **III** | 4 | --- | 4 | 4 | 4+4 |
| | | **IV** | --- | 4 | 4 | 4 | 4+4 |
| | | **Exit Point: Bachelor's Degree with Hons.** | | | | | |
| **Level 5.5** | Level 300-399: **Higher-level courses** | **V** | 4 | --- | 4 | 4 | 4+4 |
| | | **VI** | --- | 4 | 4 | 4 | 4+4 |
| | | **Exit Point: P.G. Diploma Degree** | | | | | |
| **Level 6** | Level 400-499: **Advanced courses** Hons with Research (>7.5 CGPA)/ Honours/ PG Diploma | **VII** | 4 | --- | 4 | 4 | 4+4 |
| | | **VIII** | --- | 4 | 4 | 4 | 4+4 |
| | | **Exit Point: (A) Bachelor's Degree with Hons. with Research/ (B) Bachelor's Degree with Hons./ (C) P.G. Diploma Degree** | | | | | |

## COURSES OF STUDY FOR FOUR-YEAR UNDERGRADUATE PROGRAMME 2025 onwards

**Table 4: Semester-wise Course Code and Credit Points for Single Major during the First Three Years of FYUGP**

| Semester | Common, Introductory, Major, Minor, Vocational & Internship Courses | | Credits | |
|---|---|---|---|---|
| | Code | Papers | Paper | Semester |
| I | AEC-1 | Language and Communication Skills (MIL-1; Modern Indian language Hindi/ English) | 2 | 7 Papers (20 credits) |
| | VAC-1 | Value Added Course-1 | 2 | |
| | IKS-1 | Indian Knowledge System-1 (Foundation Course) | 2 | |
| | SEC-1 | Skill Enhancement Course-1 | 3 | |
| | MDC-1 | Multi-disciplinary Course-1 | 3 | |
| | AC-1 | Associated core courses from discipline/ Interdisciplinary/ vocational | 4 | |
| | MJ-1 | Major paper 1 (Disciplinary/ Interdisciplinary Major) | 4 | |
| II | AEC-2 | Language and Communication Skills (MIL-1; Modern Indian language English/ Hindi) | 2 | 7 Papers (20 credits) |
| | VAC-2 | Value Added Course-2 | 2 | |
| | SA | Social Awareness Activities | 2 | |
| | SEC-2 | Skill Enhancement Course-2 | 3 | |
| | MDC-2 | Multi-disciplinary Course-2 | 3 | |
| | AC-2 | Associated core courses from discipline/ Interdisciplinary/ vocational | 4 | |
| | MJ-2 | Major paper 2 (Disciplinary/ Interdisciplinary Major) | 4 | |
| III | AEC-3 | Language and Communication Skills (MIL-2; MIL including TRL) | 2 | 6 Papers (20 credits) |
| | SEC-3 | Skill Enhancement Course-3 | 3 | |
| | MDC-3 | IKS as a Multi-disciplinary Course-3 | 3 | |
| | ELC-1 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | |
| | MJ-3 | Major paper 3 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-4 | Major paper 4 (Disciplinary/ Interdisciplinary Major) | 4 | |
| IV | AEC-4 | Language and Communication Skills (MIL-2; MIL including TRL) | 2 | 6 Papers (20 credits) |
| | VAC-3 | Value Added Course-3 | 2 | |
| | ELC-2 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | |
| | MJ-5 | Major paper 5 (Disciplinary/ Interdisciplinary Major having IKS) | 4 | |
| | MJ-6 | Major paper 6 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-7 | Major paper 7 (Disciplinary/ Interdisciplinary Major) | 4 | |
| V | ELC-3 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-8 | Major paper 8 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-9 | Major paper 9 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-10 | Major paper 10 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-11 | Major paper 11 (Disciplinary/ Interdisciplinary Major) | 4 | |
| VI | ELC-4 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-12 | Major paper 12 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-13 | Major paper 13 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-14 | Major paper 14 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | MJ-15 | Major paper 15 (Disciplinary/ Interdisciplinary Major) | 4 | |
| | | **Total Credits, excluding one Internship (IAP) of 4 credits =** | **120** | **120** |

**Note:** It is mandatory to take One Internship of 4 credits in any one of the semesters during the first three years in FYUGP or before exit at any of the exit points if a student wishes to opt for the same.

**Table 5A: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours with Research)**

| Semester | Common, Introductory, Major, Minor, Vocational & Internship Courses | | Credits | |
|---|---|---|---|---|
| | Code | Papers | Paper | Semester |
| VII A | ELC-5 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-16 | Major paper 16 (Research Methodology) | 4 | |
| | MJ-17 | Major paper 17 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-18 | Major paper 18 (Disciplinary/Interdisciplinary Major) | 4 | |
| | RC-1 | Research proposal – Planning & Techniques (Disciplinary/Interdisciplinary Major) | 4 | |
| VIII A | ELC-6 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 4 Papers (20 credits) |
| | MJ-19 | Major paper 19 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-20 | Major paper 20 (Disciplinary/Interdisciplinary Major) | 4 | |
| | RC-2 | Research Internship/Field Work/Project/Dissertation/Thesis | 8 | |
| | | **Total Credits, excluding one Internship of 4 credits =** | **160** | **160** |

**Table 5B: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (Honours)**

| Semester | Common, Introductory, Major, Minor, Vocational & Internship Courses | | Credits | |
|---|---|---|---|---|
| | Code | Papers | Paper | Semester |
| VII B | ELC-5 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-16 | Major paper 16 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-17 | Major paper 17 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-18 | Major paper 18 (Disciplinary/Interdisciplinary Major) | 4 | |
| | AMJ-1 | Advanced Major pape-1 (Disciplinary/Interdisciplinary Major) | 4 | |
| VIII B | ELC-6 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-19 | Major paper 19 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-20 | Major paper 20 (Disciplinary/Interdisciplinary Major) | 4 | |
| | AMJ-2 | Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) | 4 | |
| | AMJ-3 | Advanced Major paper-3 (Disciplinary/Interdisciplinary Major) | 4 | |
| | | **Total Credits, excluding one Internship of 4 credits =** | **160** | **160** |

**Table 5C: Semester-wise Course Code and Credit Points for Single Major during the Fourth Year of FYUGP for Bachelor's Degree (with Postgraduate Diploma)**

| Semester | Common, Introductory, Major, Minor, Vocational & Internship Courses | | Credits | |
|---|---|---|---|---|
| | Code | Papers | Paper | Semester |
| VII C | ELC-5 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-16 | Major paper 16 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-17 | Major paper 17 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-18 | Major paper 18 (Disciplinary/Interdisciplinary Major) | 4 | |
| | JOC-1 | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4 | |
| VIII C | ELC-6 | Elective courses from discipline/ Interdisciplinary/ vocational | 4 | 5 Papers (20 credits) |
| | MJ-19 | Major paper 19 (Disciplinary/Interdisciplinary Major) | 4 | |
| | MJ-20 | Major paper 20 (Disciplinary/Interdisciplinary Major) | 4 | |
| | JOC-2 | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4 | |
| | JOC-3 | Skill based Job Oriented paper (Disciplinary/Interdisciplinary Major) | 4 | |
| | | **Total Credits, excluding one Internship of 4 credits =** | **160** | **160** |

## AIMS OF BACHELOR'S DEGREE PROGRAMME IN GEOLOGY

*The broad aims of bachelor's degree programme in Geology are:*

1. The curriculum of B.Sc. (Hons) Geology is framed under the National Education Policy (N.E.P. 2022)to prepare its students for society.
2. Each program vividly elaborates its nature and promises the outcomes to be accomplished by studyingthe courses.
3. The Geology programs also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice, and also skills for employability.
4. Being a fast, economically developing country with depleting natural resources, acute shortage of energy, natural disasters, and many environmental hazards.
5. Two-third of the Indian subcontinent lies in the seismic zones of moderate to severe intensity. Solutionand management of many of these problems can be met by understanding the Earth more intensivelyand extensively, which could be achieved by pursuing a course in Geology.
6. It is an exciting course with both fundamental and applied utility.

## PROGRAM LEARNING OUTCOMES

*The broad aims of bachelor's degree programme in Geology are:*

(i) To help students build up a progressive and successful career in Geology
(ii) To enrich students' knowledge and train them in the pure and applied geological sciences
(iii) To provide an updated education
(iv) To impart more field-oriented knowledge
(v) To inculcate a sense of scientific responsibilities and social and environmental awareness
(vi) To inculcate values and knowledge
(vii) To make them responsible citizen
(viii) To encourage critical thinking with skills of employability
(ix) To introduce the concepts of application and research in Geology
(x) Create a sense of preservation and conservation of natural resources.
(xi) To prepare students for sustainability and life-long learning
(xii) To inculcate values and knowledge within students that will make them well-being responsible citizensand encourage critical thinking with the skill of employability
(xiii) In short, each program prepares students for sustainability and lifelong learning.

SEMESTER WISE COURSES IN GEOLOGY MAJOR-1 FOR FYUGP **2025 onwards**

Table 6: Semester wise Course Code and Credit Points of Major Courses in Geology:

| Semester | Courses | | Examination Structure | | | |
|---|---|---|---|---|---|---|
| | Code | Papers | Credits | Mid Semester Theory (F.M.) | End Semester Theory (F.M.) | End Semester Practical /Viva (F.M.) |
| I | MJ – 1 | Earth System Science | 4 | 25 | 75 | --- |
| | SEC – 1 | Geomorphology | 3 | --- | 75 | --- |
| II | MJ – 2 | Crystallography and Mineralogy | 4 | 25 | 75 | --- |
| | SEC – 2 | Basics of Geological Mapping | 3 | --- | 75 | --- |
| III | MJ – 3 | Structural Geology | 4 | 25 | 75 | --- |
| | MJ – 4 | **Practical-I** | 4 | --- | --- | 100 |
| | SEC – 3 | Elementary Computer Applications Software | 3 | --- | 75 | --- |
| IV | MJ – 5 | IKS in Geology | 4 | 25 | 75 | --- |
| | MJ – 6 | Elements of Geochemistry and Igneous Petrology | 4 | 25 | 75 | --- |
| | MJ – 7 | **Practical – II** | 4 | | | 100 |
| V | MJ – 8 | Stratigraphy and Palaeontology | 4 | 25 | 75 | --- |
| | MJ – 9 | Sedimentary and Metamorphic Petrology | 4 | 25 | 75 | --- |
| | MJ – 10 | Environmental Geology and Natural Hazards | 4 | 25 | 75 | --- |
| | MJ – 11 | **Practical – III** | 4 | --- | --- | 100 |
| VI | MJ – 12 | Economic and Exploration Geology | 4 | 25 | 75 | --- |
| | MJ – 13 | Hydrogeology and Engineering Geology | 4 | 25 | 75 | --- |
| | MJ – 14 | Geological Mapping and Image Processing Techniques | 4 | 25 | 75 | --- |
| | MJ – 15 | **Practical - IV** | 4 | --- | --- | 100 |
| VII | MJ – 16 | Fossil Fuel Geology | 4 | 25 | 75 | --- |
| | MJ – 17 | Geotectonics and Applied Structural Geology | 4 | 25 | 75 | --- |

| | | | | | | |
|---|---|---|---|---|---|---|
| | MJ – 18 | **Practical – V** | 4 | --- | --- | 100 |
| | AMJ – 1<br><br>or<br>RC – 1 | Geomorphology and RS-GIS in Geology (Only for Major / Honours)<br>or<br>Research Methodology / Planning and Techniques (Only for Major / Honours with Research) | 4 | 25 | 75 | --- |
| | | | 4 | 25 | 75 | --- |
| **VIII** | MJ – 19 | Advance Crystallography and Descriptive Mineralogy | 4 | 25 | 75 | --- |
| | MJ – 20 | **Practical – VI** | 4 | --- | --- | 100 |
| | AMJ – 2 | Geochemistry and Advance Petrology (Only for Major / Honours) | 4 | 25 | 75 | --- |
| | AMJ – 3<br><br>or<br>RC – 2 | **Practical – VII**<br>or<br>Project Dissertation/ Research Internship/ Field Work | 4 | --- | --- | 100 |
| | | | 8 | --- | --- | 200 |
| | | **Total Credits** | **105** | | | |

**Table 7: Semester wise Course Code and Credit Points for Minor Courses in Geology:**

| **Courses** | | **Examination Structure** | | | |
|---|---|---|---|---|---|
| **Code** | **Minor Courses in NEP FYUGP Syllabus of Geology** Session 2025-2026 & Onwards | **Credits** | **Mid-Semester Theory (F.M.)** | **End-Semester Theory (F.M.)** | **End-Semester Practical / Viva (F.M.)** |
| MN A | Introductory Geology | 4 | 15 | 60 | 25 |
| MN B | Essentials of Geology, Rocks and Minerals | 4 | 15 | 60 | 25 |
| MN C | Earth Resources | 4 | 15 | 60 | 25 |
| MN 1D | Fossils and Their Applications | 4 | 15 | 60 | 25 |
| MN E, F & G | ---------- | | | | |

## INSTRUCTION TO QUESTION SETTER

**SEMESTER INTERNAL EXAMINATION (SIE):**

There will be Only One Semester Internal Examination in Major, Minor and Research Courses, which will be organised at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

**A. (SIE 10+5=15 marks):**

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

**B. (SIE 20+5=25 marks):**

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

**Conversion of Attendance into score may be as follows:**

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

**END SEMESTER UNIVERSITY EXAMINATION (ESE):**

**A. (ESE 50 marks):**

There will be two group of questions. **Group A is compulsory** which will contain one question. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

**B. (ESE 60 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

**C. (ESE 75 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

**D. (ESE 100 marks):**

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of twenty marks each, out of which any four are to answer.

## FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **15 Marks**:

**Subject/ Code**

**F.M.** =15 **Time** = 1 Hr. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

**Group B**

2. ..... [10]
3. ..... [10]

**Note:** There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

**Subject/ Code**

**F.M.** =20 **Time** = 1 Hr. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

**Group B**

3. ..... [10]
4. ..... [10]

**Note:** There may be subdivisions in each question asked in the Theory Examination.

Question format for **50 Marks**:

**Subject/ Code**

**F.M.** =50 **Time** = 1.5 Hrs. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

**Group B**

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

**Note:** There may be subdivisions in each question asked in the Theory Examination.

Question format for **60 Marks**:

**Subject/ Code**

**F.M.** =60 **Time** = 3 Hrs. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

**Group B**

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

**Note:** There may be subdivisions in each question asked in the Theory Examination.

## Question format for **75 Marks**:

**Subject/ Code**

**F.M.** =75 **Time** = 3 Hrs. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

**Group B**

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

**Note:** There may be subdivisions in each question asked in the Theory Examination.

## Question format for **100 Marks**:

**Subject/ Code**

**F.M.** =100 **Time** = 3 Hrs. Exam Year

**General Instructions:**

i. **Group A** carries very short answer-type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all subparts of a question in one place.
v. Numbers in the right indicate full marks for the question.

**Group A**

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x. .....
2. ..... [5]
3. ..... [5]

**Group B**

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

**Note:** There may be subdivisions in each question asked in the Theory Examination.

# Semester I

## Major Course – MJ 1: Earth System Science

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives**

To provide a fundamental understanding of the Earth in the solar system along with its origin, evolution, and different components; to understand the potential fields associated with Earth; the evolution of life through geological time scale.

**Course Learning Outcomes**

After the completion of the course, the students will be able to:

Acquire a fundamental understanding of the Earth and its components, thorough an understanding of materials and processes of the Earth and apply the knowledge of earth science to address societal issues.

**Course Content:**

**Unit 1: Origin and Evolution of Earth and Solar System**

The Universe and the Big Bang Theory, Origin of the Solar System – Nebular Hypothesis, Planetesimal and Protoplanet Hypotheses, The terrestrial and Jovian planets. Meteorites and Asteroids Geological Time Scale – concept of deep time. Age of the Earth and methods of dating (radiometric and relative). Internal structure of the Earth (based on seismic and density data).

**Unit 2: Earth as a System: Components and Interactions**

Earth System concept – Lithosphere, Atmosphere, Hydrosphere and their interactions.

Energy sources of the dynamic Earth – Solar and internal heat

Earth's heat flow and geothermal gradient.

Earth's magnetic field, transient magnetic field, magnetic anomalies – generation, importance and measurement.

Earth's rotation, precession, obliquity and their effects.

**Unit 3: Plate Tectonics and Earth's Dynamics**

Plate Continental drift and sea-floor spreading concepts.

Plate tectonic theory – types of plate boundaries and associated features.

Earthquakes: types, causes, distribution and volcanoes: types, causes, distribution and products.

Mountain building processes (Orogeny) and concept of isostasy.

**Unit 4: Earth Materials and Cycles**

Introduction to rocks and minerals – basic classification and characteristics.

Rock cycle – interrelationship of igneous, sedimentary, and metamorphic processes.

The hydrological cycle – processes and global water balance.

The biogeochemical cycles (carbon, nitrogen, and phosphorus).

Earth's carbon reservoirs and climate regulation.

**Unit 5: Earth System Evolution and Human Impacts**

Evolution of the atmosphere and oceans.

Major Earth system changes through geologic time (Snowball Earth, Oxygenation events).

Climate change: natural and anthropogenic causes.

Human impact on the Earth system – deforestation, mining, pollution, and resource depletion.

Sustainable Earth – concept of planetary boundaries: climate change, biodiversity loss, biogeochemical flows (nitrogen and phosphorus cycles), ocean acidification, land-use change, freshwater use, ozone depletion, atmospheric aerosol loading, and introduction of novel entities (like pollutants and plastics)



***Books Recommended:***

1. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
2. Emiliani, C. (1992). Planet Earth: cosmology, geology, and the Evolution of Life and Environment. Cambridge University Press.
3. Gross, M. G. (1977). Oceanography: A view of the Earth.
4. Krishnan, M. S. (1982). Geology of India and Burma, C.B.S. Publishers, Delhi.
5. Kumar, R. (1991). Fundamentals of Historical Geology and Stratigraphy of India. New Age International Publishers.

# Skill Enhancement Course – SEC 1: Geomorphology

**Marks Distribution: 75 (ESE: 3 Hrs)**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To develop understanding of landforms, geomorphic processes, and their evolution.

To enhance practical skills in interpretation of topographic and satellite maps.

To train students in identifying geomorphic features useful in applied fields such as engineering geology, environmental studies, and hazard mapping.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Identify and classify major landforms and explain their genesis.

Interpret geomorphic features using topographic and satellite data.

Analyze drainage and slope characteristics quantitatively.

Apply geomorphological knowledge to hazard mapping, site selection, and resource management.

**Course Content:**

**Unit-1: Fundamentals of Geomorphology**

Definition, scope, and significance of Geomorphology.

Earth's surface configuration: continents, oceans, and major physiographic divisions.

Structure–process–stage relationships in landform development.

Endogenic and exogenic processes.

**Unit-2: Geomorphic Processes and Agents**

Weathering: types, factors, and geomorphic significance.

Erosion, transportation, and deposition – controlling factors.

Fluvial processes and landforms: valleys, floodplains, deltas, and alluvial fans.

Aeolian processes and landforms: dunes, loess, and desert pavements.

Glacial processes and landforms: cirques, moraines, drumlins, and outwash plains.

Coastal and karst landforms: cliffs, beaches, stacks, caves, sinkholes, and towers.

**Unit-3: Theories of Landform Evolution**

Davis's cycle of erosion.

Penck's theory of slope evolution.

King's pediplanation model.

Polycyclic and polygenetic landscapes.

**Unit-4: Applied and Quantitative Geomorphology**

Drainage basin analysis: patterns, ordering, and morphometric parameters.

Slope analysis and its significance.

Geomorphology and natural hazards: landslides, floods, coastal erosion.

Geomorphology in engineering and environmental planning.

**Unit-5**: **Skill Based Component**

Interpretation of topographic maps and identification of landforms.

Preparation of longitudinal and transverse profiles.

Drainage pattern and morphometric analysis (stream order, bifurcation ratio, drainage density).

Slope analysis using contour maps.

Preparation of geomorphological maps of selected regions.

Field identification and description of geomorphic features.

**Books Recommended:**


1. Allen, P., 1997. Earth Surface Processes. Blackwell
2. Bloom, A.L., 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition).
3. Keary, P. and Vine, F.J., 1997. Global Tectonics. Blackwell and crustal evolution. Butterworth-Heinemann.
4. Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.
5. Moores, E and Twiss. R.J., 1995. Tectonics. Freeman.
6. Patwardhan, A. M., 1999. The Dynamic Earth System. Prentice Hall.
7. Summerfied, M.A., 2000. Geomorphology and Global tectonic. Springer Verlag.
8. Valdia, K.S., 1988. Dynamic Himalaya. Universities Press, Hyderabad.
9. WD Thornbury, 2002. Principles of Geomorphology. CBS Publ. New Delhi.
10. Verma, V.K., 1986. Geomorphology Earth surface processes and form. McGraw Hill.
11. Chorley, R. J., 1984. Geomorphology. Methuen.
12. Selby, M.J., 1996. Earths Changing Surface. Oxford University Press UK.

# Semester II

## Major Course – MJ 2:

## Crystallography and Mineralogy

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To provide a fundamental understanding of crystal system, symmetry and chemistry to understand the importance of minerals in our daily life; to provide comprehensive knowledge of the structure of silicates and different groups of minerals.

**Course Learning Outcomes:**

After the completion of the course, students will be able to:

Have a good understanding of the different symmetry elements, a comprehensive understanding of the importance and application of minerals/mineral groups, knowledge of the Structure and composition, the economic importance of minerals and building an overall knowledge in geology, knowledge of application and usage of minerals in industries.

**Course Content:**

**Unit-1: Fundamentals of Crystallography: Morphology, Symmetry, and Classification**

Crystallography: Elementary ideas about crystal morphology concerning internal structures, Crystal parameters and indices, Crystal symmetry and Classification of crystals into six systems (Normal Class).

**Unit-2: Crystal Symmetry, Projections, and Structural Chemistry**

Crystal symmetry and projections, Elements of crystal chemistry and aspects of crystal structures, Stereographic projections of symmetry elements and forms.

**Unit-3: Rock-Forming Minerals: Classification, Properties, and Crystal Structures**

Rock-forming minerals: Minerals-definition and Classification, physical and chemical properties, Composition of common rock-forming minerals, Silicate and non-silicate

structures; C.C.P. and H.C.P. structures.

**Unit-4: Optical Mineralogy: Properties of Light and Microscopic Identification of Rock-Forming Minerals**

Properties of light and optical microscopy, Nature of light and principles of optical mineralogy Introduction to the petrological microscope and identification of common rock-forming minerals.

**Unit-5: Physical, Chemical, and Optical Properties of Key Rock-Forming Mineral Groups**

Description of physical, chemical and optical properties of the following mineral groups: Olivine, Pyroxene, Amphibole, Quartz, Mica and Feldspar.

**Books Recommended:**

1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
5. Read, H.H. (1988). Elements of Mineralogy. Surjeet Publication.

# Skill Enhancement Course – SEC 2:

# Basics of Geological Mapping

**Marks Distribution: 75 (ESE: 3 Hrs)**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To impart fundamental knowledge of geological mapping and field techniques.

To train students in observation, recording, and interpretation of geological data in the field.

To develop skills in reading and preparing geological maps and cross-sections.

To introduce the use of basic field instruments and field notebooks.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Read, interpret, and construct geological maps and cross-sections.

Measure and record geological structures accurately in the field.

Prepare geological field reports with sketches and interpretations.

Use field instruments effectively and safely.

Understand how geological mapping supports mineral exploration, engineering, and environmental studies.



**Course Content:**

**Unit-1: Fundamentals of Geological Mapping**

Definition, purpose, and types of geological maps.

Topographic maps: scale, symbols, contour interpretation, and orientation.

Relationship between topography and geology.

Elements of geological maps: strike, dip, bedding, fold, fault, unconformity, etc.

Importance of accurate observation, note-taking, and sketching in the field.

**Unit-2: Field Instruments and Techniques**

Basic field equipment: compass-clinometer, GPS, hammer, hand lens, and measuring tape.

Use and handling of Brunton Compass — measurement of strike and dip.

Methods of locating positions and determining directions in the field.

Collection and labeling of rock samples.

Methods of traversing and outcrop mapping.

**Unit-3: Geological Map Reading and Interpretation**

Types of geological maps: simple, folded, faulted, unconformable sequences and their recognition on maps.

Understanding map symbols, colors, and legends (GSI standard).

Rules for constructing geological cross-sections.

Interpretation of geological history from maps.

Exercises in horizontal, vertical, and inclined strata.

**Unit-4: Geological Mapping in the Field**

Preparation of a base map from a topographic sheet.

Mapping of lithological boundaries and structural data.

Construction of cross-section from field data.

Preparation of field report with maps, logs, and stratigraphic columns.

Description of lithology, structures, and sequence of geological events.

Introduction to use of GPS and Google Earth for field mapping.

**Unit-5: Map Presentation and Report Writing**

Plotting and presentation of structural data using rose diagrams and stereonets (introductory level).

Preparation of geological maps and cross-sections on fair sheets.

Writing a geological field report – structure, style, and standard format.

Ethical practices and safety measures during fieldwork.



**GEOLOGICAL SITE VISIT.**

**Books Recommended:**

1. Compton, R.R. (1985). Geology in the Field. John Wiley & Sons.
2. Lahee, F.H. (1961). Field Geology. McGraw Hill.
3. Barnes, J.W. (1981). Basic Geological Mapping. Longman.
4. Tucker, M.E. (2011). Sedimentary Rocks in the Field. Wiley-Blackwell.
5. Coe, A.L. (2010). Geological Field Techniques. Wiley-Blackwell.

# Semester III

## Major Course – MJ 3: Structural Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the principles of rock deformation and tectonic forces.

To identify and classify primary and secondary structures in rocks.

To study geometry and mechanics of folds, faults, joints, and unconformities.

To interpret structural data for preparation of geological maps and cross-sections.

To build skills essential for field mapping, mining, civil, and petroleum geology.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Classify and describe geological structures in the field and lab.

Interpret stress–strain behavior and deformation patterns in rocks.

Identify and analyze folds, faults, joints, and unconformities on maps and in the field.

Construct and interpret geological cross-sections and structure contour maps.

Understand structural controls on mineralization and tectonic evolution.

**Course Content:**

**Unit-1: Introduction to Structural Geology and Geologic Structures**

Definition, scope, and importance of Structural Geology.

Concept of rock deformation: brittle vs. ductile deformation.

Primary and secondary structures in rocks.

Attitude of planar and linear features — strike, dip, plunge, rake / pitch.

Methods of representing structural data: symbol conventions and map notations.

**Unit-2: Stress, Strain, and Folds**

Concepts of stress and strain in rocks; types of stress (compressional, tensional, shear).

Strain ellipse, strain markers, and strain measurement.

Folds – definition, geometry, and elements: hinge, limb, axial plane, axis, and plunge.

Classification of folds: based on geometry, orientation, and mechanism (Fleuty and Ramsay classification).

Recognition of folds in the field and on geological maps.

Causes and mechanics of folding.

Economic and structural significance of folds.

**Unit-3: Faults and Joints**

Faults: definition, elements (fault plane, hanging wall, footwall, etc.).

Classification of faults: normal, reverse, thrust, strike-slip, and oblique-slip.

Recognition criteria in field and on maps.

Effects of faults on outcrops and strata.

Causes and mechanics of faulting.

Economic significance of faults (ore localization, groundwater movement).

Joints: definition, types (tensional, shear, columnar, bedding, and exfoliation joints).

Relationship of joints with folds and faults.

**Unit-4: Unconformities, Foliation, and Lineation**

Unconformities: types (angular, disconformity, nonconformity, paraconformity) — recognition and significance.

Overlap and offlap structures.

Foliation and Lineation: definition, types, and origin.

Cleavage, schistosity, gneissosity, and lineation (mineral, intersection, stretching).

Relation of foliation and lineation with folding and metamorphism.

Structural control of mineralization.

**Unit-5: Geological Maps, Cross Sections, and Tectonic Implications**

Geological map interpretation: structure contours, outcrop patterns, and dip–strike relationships.

Recognition of geological structures from topographic and contour maps.

Concept of tectonic structures – domes, basins, nappes, klippen, and fensters.

Introduction to plate tectonics and its structural implications.

Relationship between regional tectonics and local structures.

**Books Recommended:**


1. Billings, M.P. (1972). Structural Geology (3rd Ed.). Prentice Hall.
2. Ramsay, J.G., & Huber, M.I. (1987). The Techniques of Modern Structural Geology. Academic Press.
3. Park, R.G. (2005). Foundations of Structural Geology (3rd Ed.). Chapman & Hall.
4. Hobbs, B.E., Means, W.D., & Williams, P.F. (1976). An Outline of Structural Geology. Wiley.
5. Davis, G.H., Reynolds, S.J., & Kluth, C.F. (2012). Structural Geology of Rocks and Regions. Wiley.
6. Ramsay, J.G. (1967). Folding and Fracturing of Rocks. McGraw-Hill.
7. Ghosh, S.K. (1993). Structural Geology: Fundamentals and Modern Developments. Pergamon.
8. Rastogi, R.P. (2009). Structural Geology and Tectonics of India. New Age International

# Major Course – MJ 4: Practical I

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To train students in identification, description, and classification of common rock-forming and ore minerals.

To familiarize students with basic geochemical data handling and diagram preparation.

To develop hands-on skills in crystal geometry, optical properties, and simple analytical interpretation.

**Course Learning Outcomes:**

After successful completion of MJ-4, students will be able to:

Identify common rock-forming and ore minerals in hand specimen.

Recognize and describe basic crystal forms and symmetry.\

Use elementary optical and geochemical techniques.\

Handle and interpret basic chemical data graphically.

Prepare mineralogical reports and maintain systematic lab records.

**Practical Content:**

1. Observation and documentation of the symmetry of crystals
2. Measurement of crystal angles using a contact goniometer.
3. Drawing and labeling of crystal forms with Miller indices.
4. Study of physical properties of minerals in hand specimen: Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz,

Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite, Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose-quartz, Smoky-quartz, Rock crystal.

5. Study of some essential silicate minerals under an optical microscope and their characteristic properties.
6. Drawing and interpretation of geological cross-sections.
7. Problems involving inclined strata, faults and folds.
8. Solving structural (dip-strike) problems using stereographic method.

# Skill Enhancement Course – SEC 3:

# Elementary Computer Applications

**Marks Distribution: 75 (ESE: 3 Hrs)**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

The objective of the course is to generate qualified manpower in Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices, whether Govt. or Private or for future entrepreneurs in the field of IT.

## A. INTRODUCTION TO COMPUTER SYSTEM

Basic Concept of Computer: What is Computer, Applications of Computer, Types of computers, Components of Computer System, Central Processing Unit (CPU) (3 Lecture)

Concepts of Hardware: Input Devices, Output Devices, Computer Memory, Types of Memory, processing Concept of Computer. (4 Lectures)

Operating system: What is an Operating System, Operating System Examples, Functions of Operating System (Basic), Introduction to Windows 11, Working on Windows 11 environment, Installation of Application Software, My Computer, Control Panel, searching techniques in windows environment, Basic of setting. (6 Hours)

Concept of Software: What is Software, Types of Software, Computer Software- Relationship between Hardware and Software, System Software, Application Software, some high-level languages. (4 Hours)

Internet & its uses: Basic of Computer networks; LAN, WAN, MAN, Concept of Internet, Applications of Internet; connecting to internet, what is ISP, World Wide Web, Web Browsing software's, Search Engines, URL, Domain name, IP Address, using e-governance website, Basics of electronic mail, getting an email account, Sending and receiving emails. (6 Hours)

## B. MICROSOFT OFFICE 2016 AND LATEST VERSIONS

Microsoft Word: Word processing concepts, Creation of Documents, Formatting of Documents, Formatting of Text, Different tabs of word 2016 environment, Formatting Page, Navigation of Page, Table handling, Header and footer, Page Numbering, Page Setup, Find and Replace, Printing the documents. (7 Hours)

Microsoft Excel (Spreadsheet): Spreadsheet Concepts, Creating, Saving and Editing a

Workbook, Inserting, Deleting Work Sheets, Formatting worksheet, Excel Formula, Concept of charts and Applications, Pivot table, goal seek, Data filter, data sorting and scenario manager, printing the spreadsheet. (6 Hours)

Microsoft Power Point (Presentation Package): Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in Power point, Animation, slide show, Master Slides, creating photo album, Rehearse timing and record narration. (5 Hours)

Digital Education: What is digital education, Advantages of digital Education, Concept of e-learning, Technologies used in e learning. (4 Hours)

**Books Recommended:**


1. Nishit Mathur, Fundamentals of Computer, APH publishing corporation (2010)
2. Neeraj Singh, Computer Fundamentals (Basic Computer), T Balaji, (2021)
3. Joan Preppernau, Microsoft Power Point 2016 step by step, Microsoft press (2015)
4. Douglas E Corner, The Internet Book 4th Edition, prentice –Hall (2009)
5. Steven Welkler, Office 2016 for beginners, Create Space Independent Publishing Platform (2016)
6. Wallace Wang, Microsoft Office 2019, Wiley (January 2018)
7. Noble Powell, Windows 11 User Guide for Beginners and Seniors, ASIN, (October 2021)

# Semester IV

## Major Course – MJ 5: IKS in Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

By the end of this course, students will be able to:

Understand the historical significance of mining and mineral use in ancient India.

Explore the connection between geology and Indian myths, culture, and heritage.

Recognize the roles of early Indian and British geologists in shaping India's geological knowledge.

Appreciate the value of geoheritage sites and the importance of their conservation.

Identify key geological institutions in India and their contributions to society.

**Course Learning Outcomes**:

Upon successful completion of this course, students will be able to:

Describe early mining practices and mineral processing techniques in ancient India.

Explain the concept of geomythology and give examples from Indian traditions.

Discuss the contributions of pioneering geologists to India's geological survey and resource development.

Identify major geoheritage sites in India and explain their scientific, cultural, and educational value.

Recognize the role of national geological institutions in research, education, and sustainable development.



**Course Content:**

**Unit-1: IKS, Earth Systems, and Sustainable Development Goals (SDGs)**

Introduction to IKS in environmental conservation.

Formation, characteristics and qualities of five elements of Nature; Earth and Atmosphere; Astronomical foundation concepts of solar system, and meteors.

Environment components and related practices in scriptures; Current need of IKS for sustainability and sustainable development goals.

**Unit-2: India's Geological Past – From Ancient Mines to Myths**

Early mining and use of minerals in ancient India

Introduction to geomythology: rocks, landforms, and folklore in Indian culture

Key contributions of renowned geologists

Role of geology in nation-building and resource mapping

**Unit-3: Mineral Processing and Elemental Science in Medieval World**

Minerals, metals and chemistry in Ancient and Medieval India

Mineral Processing in 13$^{th}$ Century India

Medieval India'a primacy in Zinc

**Unit-4: Introduction to Ancient Environmental Sustainability**

Traditional knowledge systems related to water management stepwells (baolis), check dams (johads) and tank irrigation, and ecological balance.

Application of sustainable practices derived from ancient texts and practices.

Integration of IKS in contemporary environmental conservation efforts.

**Unit-5: Geoheritage, Conservation, and Geological Institutions**

What is geoheritage? Importance and examples in India

Overview of major geoheritage sites (with emphasis on accessibility and relevance)

Introduction to geotourism and sustainable conservation

Major geological institutions in India (e.g., GSI, NGRI, IITs, universities) and their societal roles

**Books Recommended:**

1. Arun Kumar Biswas, Mineral Processing to Elemental Science in The Medieval World: India And Europe, Asiatic Society of India
2. Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan et al.
3. Indian Knowledge System by Kapil Kapoor and Avadhesh Kumar Singh
4. Traditional Knowledge System in India by Amit Jha
5. N. R. Banerjee, Mining and Metallurgy in Ancient India, Archaeological Survey of India (1985)
6. Debiprasad Chattopadhyaya, Science and Society in Ancient India. K P Bagchi &

Company, 2014.

7. Christopher K. Chapple, 'Towards an indigenous Indian environmentalism', in Nelson E., Lance, (ed.), Purifying the Earthly Body of God, p. 20, State University of New York Press, Albany, 1998.
8. Science and Technology in Ancient Indian Texts, Bal Ram Singh, D.K. Print World Ltd, 2012.
9. O.P. Dwivedi, Environmental Crisis and Hindu Religion, Gitanjali Publishing House, Delhi, 1987
10. Rajasekaran, B. (1993). A framework for incorporating indigenous knowledge systems into agricultural research and extension organizations for sustainable agricultural development in India. Iowa State University.
11. Environmental Consciousness and Sustainable Development in the Indian Knowledge System. Dr Vedprakash Bokar, R. Narayan and J. Kumar, Ecology and Religion: Ecological Concepts in Hinduism, Buddhism, Jainism, Islam, Christianity and Sikhism, Deep and Deep Publications, New Delhi, 2003
12. Vipul Singh, The Human Footprint on Environment: Issues in India, Macmillan India, New Delhi, 2012

# Major Course – MJ 6:

# Elements of Geochemistry and Igneous petrology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

This course aims to:

Introduce the fundamental concepts, scope, and applications of geochemistry in Earth sciences.

Explain the chemical composition and differentiation of Earth's major reservoirs and the classification of elements.

Explore key geochemical processes, cycles, and the role of isotopes in understanding Earth's evolution.

Provide a foundation in igneous petrology, including magma generation, differentiation, and crystallization.

Examine phase equilibria, tectonic controls on magmatism, and the origin of major igneous rock types.

**Course Learning Outcomes:**

Upon successful completion of this course, students will be able to:

Define geochemistry and describe the structure, composition, and geochemical layering of the Earth.

Classify elements using Goldschmidt's scheme and interpret their distribution in Earth's reservoirs based on cosmic abundance and differentiation processes.

Explain major geochemical cycles (e.g., C, S, N) and assess the mobility, fixation, and migration of elements during weathering and mineral formation.

Use stable and radiogenic isotopes to interpret geological processes and identify geochemical anomalies relevant to mineral exploration.

Describe the origin, evolution, and differentiation of magmas using concepts such as geothermal gradients, Bowen's Reaction Series, and magmatic processes.

Interpret binary phase diagrams (e.g., An–Ab, Di–An) to explain crystal–melt equilibria and predict mineral crystallization sequences.

Relate magmatic activity to tectonic settings (e.g., MORB, OIB, island arcs, continental arcs) and explain differences in magma composition.

Analyze the petrogenesis of key igneous rock types—including komatiites, basalts, granitoids, gabbros, alkaline rocks, kimberlites, and lamproites—based on source, tectonic setting, and melting conditions.

**Course Content:**

**Unit-1: Introduction to Geochemistry**

Definition, scope, and significance of Geochemistry.

Structure and composition of the Earth (core, mantle, crust).

Geochemical classification of elements: Goldschmidt's classification (lithophile, siderophile, chalcophile, atmophile).

Cosmic abundance of elements and geochemical differentiation of the Earth.

Major, minor, and trace elements — definitions and geological significance.

Concept of geochemical reservoirs and mass balance.

**Unit-2: Geochemical Processes and Cycles**

Geochemical processes: magmatic, sedimentary, and metamorphic differentiation.

Geochemical mobility of elements.

Geochemical cycle, Isotope geochemistry – stable and radiogenic isotopes (basics and applications).

Geochemical anomalies and their use in mineral exploration.

**Unit-3: Introduction to Petrology and Igneous Processes**

Scope and branches of petrology.

Definition and formation of igneous rocks.

Nature of magma: composition, temperature, viscosity, and volatile content.

Types of magma – basaltic, andesitic, rhyolitic.

Magmatic processes: crystallization, differentiation, assimilation, magma mixing, and contamination.

Forms of igneous bodies: concordant and discordant (dyke, sill, batholith, laccolith, lopolith, phacolith).

**Unit-4: Textures, Structures, and Classification of Igneous Rocks**

Textures and structure of igneous rocks: definitions, types.

Classification of igneous rocks:

Chemical (based on silica content)

Mineralogical (mode and norm)

CIPW norm classification (concept only)

IUGS (QAPF, TAS) classification of plutonic and volcanic rocks.

Petrogenesis of major igneous rock types: Granite, basalt, gabbro, rhyolite, andesite, pegmatite and peridotite, Komatiites, Alkaline rocks, Kimberlites, Ophiolite.

Introduction to igneous provinces of India: Deccan Traps, Rajmahal Traps, and Chotanagpur Granite Gneiss Complex, Igneous Layered complexes.

**Unit-5: Textures, Structures, and Classification of Igneous Rocks**

Phase diagrams and petrogenesis: Binary Phase diagrams in understanding crystal-melt equilibrium – An-Ab, Or-Ab, Di-An Magma generation in crust and mantle, their emplacement and evolution

Magmatism in different tectonic settings: Magmatism in the oceanic domains (MORB, O.I.B.) Magmatism along the plate margins (Island arcs/continental arcs).

Petrogenesis of Igneous rocks: Petrogenesis of Felsic and Mafic igneous rocks

**Books Recommended:**


1. Goldschmidt, V.M. (1954). Geochemistry. Clarendon Press.
2. Mason, B., & Moore, C.B. (1982). Principles of Geochemistry. Wiley.
3. Deer, W.A., Howie, R.A., & Zussman, J. (1992). An Introduction to the Rock-Forming Minerals. Longman.
4. Klein, C., & Dutrow, B. (2012). Manual of Mineral Science (23rd ed.). Wiley.
5. Rollinson, H.R. (1993). Using Geochemical Data: Evaluation, Presentation, Interpretation. Longman.
6. Berry, L.G., Mason, B., & Dietrich, R.V. (1983). Mineralogy: Concepts, Descriptions, Determinations. Freeman.
7. Krauskopf, K.B., & Bird, D.K. (1995). Introduction to Geochemistry. McGraw Hill.
8. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications, Wiley India Pvt.
9. Philpotts, A. & Ague, J. (2009). Principles of igneous and metamorphic petrology.

Cambridge University Press.

10. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
11. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, Interpretation. Routledge.
12. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
13. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
14. 7Best, M.G. (2001). Igneous and Metamorphic Petrology, K.G. Cox, J.D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
15. Bose, M.K. (1997). Igneous Petrology.
16. Tyrrell, G.W. (1926). Principles of Petrology. Springer.

# Major Course – MJ 7: Practical II

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To develop skills for identification and description of igneous rocks in hand specimens and thin sections.

To understand the textures, structures, and mineralogical compositions of rocks.

To classify rocks using standard petrographic and field methods.

To prepare students for field interpretation and geological mapping involving various rock types.

**Learning Outcomes:**

After completing this practical course, students will be able to:

Identify and describe igneous rocks both in hand specimen and thin section.

Classify rocks based on textures, mineralogy, and genesis.

Interpret field relations and tectonic settings of rock formations.

Prepare professional-level petrographic records and field notes.

Apply petrological knowledge to geological mapping and exploration.

**Practical Content:**

Geochemical data analysis and Interpretation of typical geochemical plots

Geochemical analysis of geological materials

Geochemical variation diagrams and their interpretations

Study of important igneous rocks in hand specimens and thin sections.

Study of important igneous rocks in hand specimens and thin sections

Q.A.P. and Q.A.P.F. Diagrams.

**Fieldwork:**

Geological mapping of one-week duration in a geologically complex area and Field Work Report based on it.

**Books Recommended:**

1. Kerr, P.F. (1959). Optical Mineralogy. McGraw Hill.
2. Winter, J.D. (2014). Principles of Igneous and Metamorphic Petrology. Pearson.
3. Tucker, M.E. (2001). Sedimentary Petrology. Blackwell.
4. MacKenzie, W.S., & Guilford, C. (1980). Atlas of Igneous and Metamorphic Rocks under the Microscope. Longman.
5. Moorhouse, W.W. (1959). The Study of Rocks in Thin Section. Harper & Row.
6. Pettijohn, F.J. (1975). Sedimentary Rocks. Harper & Row.

# Semester V

## Major Course – MJ 8:

## Stratigraphy and Palaeontology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

This course aims to:

Introduce the foundational principles, methods, and historical development of stratigraphy and paleontology.

Develop an understanding of stratigraphic correlation, nomenclature, and the geological time scale.

Provide a systematic overview of the stratigraphic framework of India—from Precambrian to Cenozoic.

Explain fossilization processes, major fossil groups, and their role in interpreting Earth's history.

Equip students with tools to use fossils and stratigraphic data in economic geology, paleoenvironmental reconstruction, and resource exploration.

**Course Learning Outcomes:**

Upon successful completion of this course, students will be able to:

Define stratigraphy and apply its fundamental principles (e.g., superposition, original horizontality, faunal succession) to interpret rock sequences.

Classify and correlate rock units using lithostratigraphic, biostratigraphic, and chronostratigraphic methods, including recognition of marker beds and unconformities.

Interpret the International Geological Time Scale and explain the hierarchy of stratigraphic nomenclature and codes.

Summarize the stratigraphic architecture of India, including key Precambrian cratons (Dharwar, Singhbhum, Aravalli–Delhi, Cuddapah, Vindhyan) and Phanerozoic basins (Gondwana, Deccan, Siwalik, Kutch).

Describe the processes of fossilization and distinguish between body fossils, trace fossils,

microfossils, and pseudofossils.

Identify major invertebrate fossil groups (e.g., corals, brachiopods, trilobites, ammonoids) based on morphology, geological range, and stratigraphic utility.

Recognize key vertebrate and plant fossils (e.g., Siwalik fauna, Glossopteris flora) and explain their evolutionary and stratigraphic significance in the Indian context.

Apply concepts of organic evolution, extinction events (e.g., Permian–Triassic, K–Pg), and index fossils to resolve biostratigraphic problems.

Use fossils and stratigraphic data for paleoenvironmental, paleoclimatic, and paleogeographic reconstructions.

Evaluate the applied value of micropaleontology and paleontology in hydrocarbon exploration, coal geology, and groundwater studies.

**Course Content:**

**Unit-1: Fundamentals of Stratigraphy**

Definition, scope, and importance of stratigraphy.

Concepts of stratotypes.

Principles of stratigraphy: Law of superposition, original horizontality, lateral continuity, and faunal succession.

Concepts of correlation – lithologic, palaeontologic, and chronologic correlation.

Stratigraphic terminology and codes.

Geological Time Scale (International Chronostratigraphic Chart – overview).

**Unit-2: Principles and Methods of Stratigraphy**

Lithostratigraphic units – formation, member, bed, group, and supergroup.

Concept of key beds, marker horizons, and unconformities.

Concept of facies, transgression, and regression.

Biostratigraphy – principles of faunal succession, biozones (range, interval, assemblage, and concurrent range zones).

Introduction to other stratigraphic methods:

Chronostratigraphy

Magnetostratigraphy

Sequence stratigraphy (basic concept)

Chemostratigraphy and Seismic stratigraphy (introductory overview).

**Unit-3: Precambrian Stratigraphy of India**

Outline of Indian shield areas and their tectonic framework.

Dharwar Supergroup: lithology, distribution, economic significance (Karnataka, Bellary, Chitradurga).

Aravalli and Delhi Supergroups: lithology, structure, and tectonic significance.

Cuddapah and Vindhyan Basins: stratigraphy, sedimentation, and fossil content (if any).

Chotanagpur Gneissic Complex and Singhbhum Craton: geological characteristics and correlation.

Economic importance of Precambrian formations (iron, manganese, copper, gold).

**Unit-4: Phanerozoic Stratigraphy of India**

Paleozoic: Distribution, lithology, and fossil content of the Spiti–Kashmir and Peninsular regions.

Mesozoic:

Gondwana Supergroup – lithology, floral and faunal succession, and economic importance (coal basins).

Jurassic and Cretaceous sequences of Kutch, Rajasthan, and South India.

Deccan and Rajmahal Volcanic Provinces – stratigraphy, extent, and significance.

Cenozoic:

Tertiary sequences of Assam–Meghalaya, Kutch and Himalayan foothills.

Siwalik Group – lithology, fossil content, and tectonic significance.

Important Stratigraphic Boundaries in India:

a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary

**Unit-5: Introduction to Paleontology and Fossilization**

Definition, scope, and importance of paleontology.

Fossilization process: modes of preservation – petrifaction, permineralization, casts, molds, carbonization, and impressions.

Types of fossils: body fossils, trace fossils, microfossils, and pseudo-fossils.

Uses of fossils in stratigraphy, paleoecology, paleoclimatology, and economic geology.

**Unit-6: Species Concept, Evolution, and Extinction**

Definition of species, genus, and population.

Organic evolution – theories (Lamarckism, Darwinism, Neo-Darwinism).

Modes of evolution – anagenesis, cladogenesis, convergent and divergent evolution.

Adaptive radiation and evolutionary trends in major groups.

Extinction: causes, mass extinction events (especially end-Permian and Cretaceous–Paleogene).

Concept of index fossils and their use in biostratigraphy.

**Unit-7: Invertebrate Paleontology (Major Fossil Groups)**

Study of morphology, classification (up to order), geological range, and geological importance of:

Coelenterata – Corals (rugose, tabulate, and scleractinian)

Brachiopoda, Mollusca – Gastropoda, Bivalvia, Cephalopoda

Echinodermata – general morphology of echinoids and crinoids

Arthropoda – morphology and significance of trilobites

**Unit-8: Vertebrate Paleontology and Plant Fossils**

Vertebrate Paleontology:

General introduction to vertebrate fossil record in India.

Evolutionary trends in reptiles (classification / dinosaurs), and mammals (horse, elephant), evolution of man (Basics).

Plant Fossils: Modes of preservation (impression, compression, petrifaction).

Major Gondwana fossil plant groups – Glossopteris, Ptilophyllum, Gangamopteris and its stratigraphic significance.

**Unit-9: Applied and Micropaleontology**

Paleoecology: concept of habitat, ecology of marine and terrestrial organisms, and paleoenvironmental reconstruction.

Paleogeography: role of fossils in paleogeographic and climatic interpretations.

Micropaleontology: brief introduction and applications (foraminifera, ostracods, diatoms, pollen).

Applied paleontology: use of fossils in oil exploration, coal stratigraphy, and groundwater studies.

**Books Recommended:**


1. Wadia, D.N. (1975). Geology of India. Tata McGraw-Hill.
2. Krishnan, M.S. (1982). Geology of India and Burma. CBS Publishers.
3. Ravindra Kumar (1998). Fundamentals of Historical Geology and Stratigraphy of India. New Age International.
4. Pascoe, E.H. (1959). Manual of the Geology of India and Burma (Vol. I–III). Geological Survey of India.
5. Boggs, S. (2009). Principles of Sedimentology and Stratigraphy. Pearson.
6. Doyle, P. & Bennett, M.R. (1998). Unlocking the Stratigraphical Record. Wiley-Blackwell.
7. Naqvi, S.M. (2005). Precambrian Geology of India. Elsevier.
8. Valdiya, K.S. (2010). The Making of India: Geodynamic Evolution. Springer.
9. Shrock, R.R., & Twenhofel, W.H. (1953). Principles of Invertebrate Paleontology. McGraw-Hill.
10. Woods, H. (1961). Paleontology Invertebrate. Cambridge University Press.
11. Raup, D.M., & Stanley, S.M. (1971). Principles of Paleontology. W.H. Freeman.
12. Clarkson, E.N.K. (1998). Invertebrate Palaeontology and Evolution. Blackwell.
13. Jain, P.C. (2014). Palaeontology: The Life of the Past. Vishal Publications.
14. Doyle, P., & Bennett, M.R. (1998). Unlocking the Stratigraphical Record. Wiley.
15. Sahni, B. (1948). The Gondwana System and Glossopteris Flora of India.
16. Benton, M.J. (2015). Vertebrate Palaeontology (4th Ed.). Wiley-Blackwell.

# Major Course – MJ 9:

# Sedimentary and Metamorphic Petrology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

This course aims to:

Introduce the origin, classification, and significance of sedimentary and metamorphic rocks within the rock cycle.

Explain the processes of weathering, transport, deposition, and diagenesis that form sedimentary rocks.

Develop skills in identifying sedimentary textures, structures, and rock types, and interpreting their depositional environments.

Provide a systematic understanding of metamorphic processes, rock types, and their relationship to tectonic settings.

Highlight the economic and geological applications of petrology in resource exploration and crustal evolution studies, with examples from India.

**Course Learning Outcomes:**

Upon successful completion of this course, students will be able to:

Define sedimentary and metamorphic petrology and explain their roles in the rock cycle and Earth's crustal evolution.

Describe the processes of weathering, erosion, transportation, and deposition, and relate them to sediment supply and basin fill.

Interpret sedimentary textures (grain size, shape, roundness) and structures (bedding, cross-bedding, mud cracks, bioturbation) to reconstruct depositional environments and paleocurrent directions.

Classify clastic and non-clastic sedimentary rocks using standard schemes (e.g., Folk, Pettijohn, Dunham) and identify their field characteristics and economic uses.

Explain diagenetic processes (compaction, cementation, recrystallization) and assess their impact on porosity, permeability, and hydrocarbon reservoir quality.

Identify major sedimentary basin types (rift, foreland, cratonic) and correlate Indian examples

(e.g., Vindhyan, Gondwana, Cuddapah) with their tectonic origins.

Define metamorphism and distinguish between its types (contact, regional, dynamic, hydrothermal) based on controlling factors (P, T, fluids).

Classify metamorphic rocks by texture, mineralogy, and origin, and relate them to metamorphic facies (e.g., greenschist, amphibolite, granulite) and index minerals.

Interpret metamorphic textures (foliation, lineation, porphyroblasts) and structures to infer tectonic history and deformation conditions.

Apply petrological knowledge to practical contexts such as mineral exploration, groundwater studies, building materials, and understanding crustal evolution in Indian shield areas.

**Course Content:**

**Unit-1: Introduction to Sedimentary Petrology**

Definition, scope, and importance of sedimentary petrology.

Process of formation of sedimentary rocks, Rock cycle and relation with other petrological types.

Processes of weathering and erosion: physical, chemical, and biological.

Products of weathering and sediment supply to basins.

Sedimentary environments: continental, transitional, and marine – overview and examples.

**Unit-2: Transportation, Deposition, and Diagenesis**

Agents of transportation: wind, water, ice, and gravity.

Concept of sediment load, competence, and capacity.

Processes of deposition – mechanical and chemical.

Diagenesis: compaction, cementation, recrystallization, and lithification.

Porosity and permeability – factors influencing reservoir quality.

**Unit-3: Textures and Structures of Sedimentary Rocks**

Sedimentary textures: grain size (Wentworth scale), shape, roundness, sphericity, and surface features.

Grain size analysis – significance and interpretation (phi scale).

Fabric and packing of detrital grains.

Sedimentary structures: Primary and Secondary

Paleocurrent indicators and their geological significance.

**Unit-4: Classification and Description of Sedimentary Rocks**

Clastic Rocks:

Classification based on particle size and composition (rudaceous, arenaceous, argillaceous).

-Conglomerate, sandstone, shale and mudrocks.

Non-Clastic Rocks:

Introduction to Carbonates (limestone, dolostone), evaporites, chert, coal an ironstones (brief)

Classification of limestones (Folk and Dunham schemes).

**Unit-5: Sedimentary Basins and Applications**

Concept, classification, and evolution of sedimentary basins.

Basin types: rift, cratonic, foreland, and geosynclinal basins – examples from India (Vindhyan, Gondwana, and Cuddapah).

Provenance analysis – heavy minerals and lithic fragments as indicators.

Facies and facies associations – concept and significance.

Economic significance of sedimentary rocks: hydrocarbons, coal, building stones, and groundwater reservoirs.

**Unit-6: Metamorphism: Principles and Types**

Definition and scope of metamorphism.

Factors controlling metamorphism: temperature, pressure, fluids, and time.

Types of metamorphism: contact, regional, cataclastic, dynamic, hydrothermal, and burial metamorphism.

Metamorphic zones and facies concept (low to high grade).

Texture and structures of metamorphic rocks (foliation, lineation, schistosity, banding, porphyroblast, granoblastic).

Concept of metamorphic differentiation and polymorphism.

**Unit-7: Classification and Description of Metamorphic Rocks**

Classification based on:

Texture and mineralogy

Degree of metamorphism

Origin (parametamorphic and orthometamorphic)

Description, composition, and occurrence of common metamorphic rocks:

Slate, phyllite, schist, gneiss, quartzite, marble, hornfels, amphibolite, granulite.

Metamorphic facies.

Concept of metamorphic grades and index minerals.

Relationship between metamorphism and tectonism.

**Unit-8: Metamorphic Processes, Rock Assemblages, and Crustal Evolution**

Metasomatism and role of fluids in metamorphism, Metamorphism and Tectonism, Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde). Migmatites and anatexis – significance in crustal melting.

Concepts of Chemographic projections, Phase rule.

Metamorphic rock associations- Schists, Gneisses, Khondalite, Charnockite, Blue schists and Eclogites.

**Recommended Books:**


1. Pettijohn, F.J. (1975). Sedimentary Rocks. Harper & Row.
2. Blatt, H., Middleton, G., & Murray, R. (1980). Origin of Sedimentary Rocks. Prentice Hall.
3. Tucker, M.E. (2001). Sedimentary Petrology. Blackwell Science.
4. Boggs, S. Jr. (2009). Principles of Sedimentology and Stratigraphy. Pearson.
5. Nichols, G. (2009). Sedimentology and Stratigraphy. Wiley-Blackwell.
6. Sengupta, S.M. (2004). Introduction to Sedimentology. Oxford & IBH.
7. Tucker, M.E. (1996). Sedimentary Rocks in the Field. Wiley.
8. Turner, F.J., & Verhoogen, J. (1960). Igneous and Metamorphic Petrology. McGraw-Hill.
9. Winter, J.D. (2014). Principles of Igneous and Metamorphic Petrology (2nd ed.). Pearson.
10. Best, M.G. (2002). Igneous and Metamorphic Petrology. Blackwell.
11. Bose, M.K. (1997). Igneous Petrology. World Press.
12. Winkler, H.G.F. (1979). Petrogenesis of Metamorphic Rocks. Springer-Verlag.
13. Philpotts, A.R. (1990). Principles of Igneous and Metamorphic Petrology. Prentice Hall.
14. Bucher, K., & Grapes, R. (2011). Petrogenesis of Metamorphic Rocks (8th ed.). Springer.

# Major Course – MJ 10:

# Environmental Geology and Natural Hazards

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the relationship between geological processes and the environment.

To analyze causes, mechanisms, and impacts of natural hazards and disasters.

To develop awareness of environmental protection, sustainability, and disaster mitigation strategies.

To train students in identifying, mapping, and assessing environmental risks and hazards.

**Course Learning Outcomes:**

After completing this course, students will be able to:

Explain the geological basis of environmental processes and natural hazards.

Identify and assess potential hazard-prone areas using maps and data.

Analyze human-induced environmental problems and propose mitigation strategies.

Interpret environmental policies, laws, and frameworks for sustainable resource management.

Contribute to environmental planning and disaster risk reduction initiatives.

**Course Content:**

**Unit-1: Fundamentals of Environmental Geology**

Definition, scope, and importance of Environmental Geology.

Earth's environment: lithosphere, hydrosphere, atmosphere, and biosphere interactions.

Concept of ecosystem, energy flow, and biogeochemical cycles.

Human–environment interactions: anthropogenic impacts on geological processes.

Environmental geology and sustainable development.

Environmental impact assessment (EIA): principles and methods.

**Unit-2: Earth Resources and Environmental Issues**

Geological resources: soil, water, minerals, and energy — their sustainable use.

Environmental problems related to mining, quarrying, and deforestation.

Groundwater pollution and management.

Solid waste and hazardous waste disposal — geological considerations.

Climate change and global warming: causes, evidence, and consequences.

Carbon sequestration and renewable resources.

**Unit-3: Natural Hazards: Causes, Effects, and Distribution**

Concepts: hazard, disaster, vulnerability, risk, and resilience.

Endogenic hazards: earthquakes, volcanic eruptions, tsunamis.

Exogenic hazards: floods, landslides, soil erosion, droughts, cyclones.

Distribution of major natural hazards in India and the world.

Geological and geomorphological controls on hazard zones.

Case studies – Recent Natural hazards (with special reference to India).

**Unit-4: Hazard Assessment, Monitoring, and Mitigation**

Hazard mapping and zoning: principles and techniques.

Seismic microzonation and earthquake-resistant construction.

Landslide hazard evaluation and slope stability analysis.

Flood risk assessment and control measures.

Remote sensing and GIS applications in hazard mapping and disaster management.

Early warning systems and community-based disaster preparedness.

**Unit-5: Environmental Management and Policy Framework**

Principles of environmental management and sustainable development.

Concepts of carrying capacity and environmental planning.

Environmental laws and acts in India:

Environment (Protection) Act, 1986

Water (Prevention and Control of Pollution) Act, 1974

Air (Prevention and Control of Pollution) Act, 1981

National Green Tribunal (NGT) Act

Disaster Management Act, 2005

Role of national and international organizations (NDMA, IMD, ISRO, UNEP, UNDP, IPCC).

Public awareness and participation in environmental protection.

**Recommended Books:**


1. Keller, E.A. (2012). Introduction to Environmental Geology. Pearson.
2. Valdiya, K.S. (2010). Environmental Geology: Indian Context. McGraw-Hill.
3. Bell, F.G. (1998). Environmental Geology: Principles and Practice. Blackwell.
4. Bryant, E. (2005). Natural Hazards. Cambridge University Press.
5. Smith, K. (2013). Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
6. Srivastava, H.N. (2005). Disaster Management in India. Prentice Hall of India.
7. Government of India. Disaster Management Act, 2005.

# Major Course – MJ 11: Practical III

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To train students in practical aspects of geological map interpretation and structural analysis.

To enable identification and classification of fossils and their stratigraphic significance.

To develop understanding of stratigraphic correlation and geological history reconstruction.

To prepare students for field mapping, paleontological documentation, and geological data interpretation.

**Course Learning Outcomes:**

After completing this practical course, students will be able to:

Interpret stratigraphic sequences and fossil assemblages accurately.

Identify and classify fossils and relate them to their stratigraphic positions.

Analyze folds, faults, and unconformities from maps and field data.

Construct cross-sections and structure contour maps.

Apply integrated knowledge of stratigraphy, paleontology, and structural geology to real geological situations.

**Practical Content:**

Hazard zonation maps of India: Seismic, Landslide, Flood, Drought, Cyclone.

Study of the geological map of India and identification of major stratigraphic units

Study of rocks in hand specimens from known Indian stratigraphic horizons

Palaeogeographic reconstruction through different geological ages.

Study of fossils showing various modes of preservation

Study and labelling diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.

Megascopic and microscopic study of sedimentary and metamorphic rocks in hand specimen and under the microscope.

Documentation of sedimentary and metamorphic structures.

Palaeocurrent analysis.

Chemographic projections: ACF, AKF and AFM diagrams.

**Geological mapping of Two-weeks duration in a geologically complex area and Field Work Report based on it.**

**Books Recommended:**

1. Laboratory Manual of Geology AK Sen (Modern Book Agency Pvt. Ltd. Calcutta)
2. Singh, R. P. (1965). Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.
3. Bennison, G. M. (1990). An Introduction to Geological Structure and Maps, Fifth Edition, Edward Arnold. London. 5th Edition, 67p.

# Semester VI

## Major Course – MJ 12:

## Economic and Exploration Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the origin, classification, and distribution of economic minerals and ores.

To study ore-forming processes and controls of mineral localization.

To learn principles and methods of mineral and petroleum exploration.

To provide knowledge of sampling, reserve estimation, and evaluation of mineral deposits.

To appreciate the role of geology in sustainable resource development.

**Course Learning Outcomes:**

After completing this course, students will be able to:

Explain ore-forming processes and classify mineral deposits.

Identify and describe economic minerals and their industrial uses.

Apply exploration techniques (geological, geophysical, geochemical) in resource discovery.

Evaluate mineral reserves and understand the economics of mining projects.

Appreciate sustainable and environmentally responsible resource development.

**Course Content:**

**Unit-1: Introduction and Ore Genesis**

Definition and scope of Economic Geology.

Classification of mineral deposits (genetic, metallic, non-metallic, energy).

Processes of ore formation: magmatic segregation, hydrothermal, sedimentary, metamorphic, residual, mechanical concentration, weathering, and supergene enrichment.

Ore textures and structures – their significance in ore genesis.

Controls of ore localization: structural, stratigraphic, lithological, and physico-chemical.

**Unit-2: Metallic Mineral Deposits**

Study of mode of occurrence, distribution, and economic importance of major metallic minerals of India:

Iron, Manganese, Chromite, Bauxite, Copper, Lead-Zinc, Gold, Tin, Tungsten, and Nickel.

Associated host rocks and major Indian ore belts (Singhbhum, Bailadila, Khetri, Aravalli, etc.).

Outline of world-class deposits and comparative study.

**Unit-3: Non-Metallic and Energy Minerals**

Mode of occurrence and distribution in India of:

Non-metallic: Mica, Gypsum, Fluorite, Barite, Limestone, Phosphate, Feldspar, Kaolin, and Asbestos.

Energy resources: Coal, Petroleum, Natural Gas, Radioactive minerals (U, Th).

Coal: classification, ranks, origin, and distribution in India (Gondwana and Tertiary basins).

Petroleum: origin, migration, accumulation, reservoir rocks, traps, and Indian oil fields.

Concept of strategic, critical, and rare-earth minerals in modern economy.

**Unit-4: Mineral Exploration Methods**

Stages of exploration: reconnaissance, prospecting, detailed exploration, evaluation.

Geological, geophysical, geochemical, and geobotanical methods – principles and applications.

Remote sensing and GIS applications in mineral and groundwater exploration.

Drilling techniques, core logging, and sampling methods.

Reserve estimation – calculation of ore reserves (tonnage and grade).

Concept of cut-off grade and stripping ratio.

**Unit-5: Mineral Economics, Mining, and Resource Management**

Strategic and critical minerals for national security.

Environmental impact of mining and mineral exploitation.

Mine hazards and safety measures.

Conservation, beneficiation, and sustainable utilization of mineral resources.

Overview of National Mineral Policy and Indian mineral industry.

Introduction to Marine Mineral Resources and Deep-Sea Exploration.

**Recommended Books:**


1. Bateman, A.M. (1981). Economic Mineral Deposits. Wiley.
2. Guilbert, J.M. & Park, C.F. (1986). The Geology of Ore Deposits. Freeman.
3. Evans, A.M. (1993). Ore Geology and Industrial Minerals. Wiley-Blackwell.
4. Craig, J.R., Vaughan, D.J., & Skinner, B.J. (2011). Resources of the Earth.
5. Moon, C.J., Whateley, M.K.G., & Evans, A.M. (2006). Introduction to Mineral Exploration. Wiley.
6. Deb, S. (2012). Mineral Resource Base of India. Oxford University Press.
7. Krishnan, M.S. (1982). Geology of India and Burma. CBS.
8. Clark, G.B. (1967). Elements of Mining. John Wiley.

# Major Course – MJ 13:

# Hydrogeology and Engineering Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand occurrence, movement, and quality of groundwater.

To study engineering properties of rocks and soils relevant to civil projects.

To learn geological considerations in dams, tunnels, buildings, and slope stability.

To introduce groundwater exploration, well design, and management concepts.

To appreciate the role of the geologist in sustainable infrastructure and water planning.

**Course Learning Outcomes:**

After completing this course, students will be able to:

Explain occurrence, movement, and recharge of groundwater.

Apply geological, geophysical, and remote-sensing techniques for water exploration.

Evaluate water quality and suggest remedial measures.

Assess geotechnical suitability of sites for civil engineering projects.

Recognize and mitigate geological hazards such as landslides and earthquakes.

Integrate hydrogeological and engineering data for sustainable infrastructure design.

**Course Content:**

**Unit-1: Introduction to Hydrogeology**

Hydrological cycle and its components.

Definition, scope, and importance of hydrogeology.

Origin and distribution of groundwater; water-table and piezometric surfaces.

Rock properties affecting groundwater: porosity, permeability, specific yield, specific retention, transmissivity, storativity.

Classification of subsurface water – vadose zone, phreatic zone, confined/unconfined aquifers, perched water table.

Groundwater provinces in India

**Unit-2: Groundwater Movement and Exploration**

Darcy's Law and its applications.

Types of aquifers and flow systems; hydraulic conductivity and transmissivity.

Pumping tests: objectives, methods, and interpretation of data.

Groundwater exploration techniques:

Geological and hydrogeomorphological mapping.

Surface and subsurface geophysical methods (electrical, seismic).

Remote sensing and GIS applications.

Groundwater recharge methods and management strategies.

**Unit-3: Water Quality and Problems**

Physical, chemical, and biological characteristics of groundwater.

Standards for drinking and irrigation water (BIS, WHO).

Groundwater contamination: sources (industrial, agricultural, domestic).

Salinity, fluoride, arsenic, and nitrate problems in India.

Prevention and remediation of pollution.

Concept of watershed management and conjunctive use of surface and groundwater.

**Unit-4: Engineering Geology: Fundamentals and Rock Mechanics**

Scope and significance of Engineering Geology.

Engineering properties of rocks

Soil mechanics basics: origin, texture, permeability, and bearing capacity.

Geological investigations for civil engineering projects – site selection and sub-surface exploration.

Rock Quality Designation (RQD), Rock Mass Rating (RMR), Rock Structure Rating (RSR) and Q-system basics.

Stability of natural and man-made slopes

**Unit-5: Applied Engineering Geology**

Dams and reservoirs: geological and geotechnical considerations in site selection, problems of leakage and seepage, reservoir-induced seismicity.

Tunnels: geological factors, rock support, and problems during construction.

Bridges, roads, and buildings: foundation geology and slope considerations.

Landslides: types, causes, investigation, and preventive measures.

Earthquakes and seismic zoning of India.

Role of engineering geologist in civil, mining, and environmental projects.

**Recommended Books:**


1. Todd, D.K. & Mays, L.W. (2005). Groundwater Hydrology, 3rd Ed. Wiley.
2. Fetter, C.W. (2001). Applied Hydrogeology, 4th Ed. Prentice Hall.
3. Davis, S.N. & De Wiest, R.J.M. (1966). Hydrogeology. Wiley.
4. Krynine, D.P. & Judd, W.R. (1957). Principles of Engineering Geology. McGraw-Hill.
5. Bell, F.G. (2007). Engineering Geology. Butterworth-Heinemann.
6. Agarwal, V. (2013). Engineering and General Geology. Khanna Publishers.
7. Singh, P. (2002). Engineering and General Geology. S.K. Kataria & Sons.
8. Raghunath, H.M. (2007). Ground Water. New Age International.

# Major Course – MJ 14:

# Geological Mapping and

# Image Processing Techniques:

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the principles, methods, and tools of geological mapping in the field and laboratory.

To introduce fundamentals of aerial photographs, satellite image interpretation, and digital image processing.

To apply GIS and remote sensing techniques in geological mapping and resource exploration.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Perform geological field mapping and data recording accurately.

Interpret aerial and satellite imagery for geological applications.

Use GIS and image processing tools for geological analysis and map preparation.

Integrate field data and remote sensing information for resource and hazard mapping

**Course Content:**

**Unit-1: Introduction to Geological Mapping**

Objectives and importance of geological mapping.

Topographic maps, scales, and coordinate systems.

Principles of field mapping: base map preparation, field notebooks, and data recording.

Measurement of strike and dip, attitude of planar and linear structures.

Preparation of outcrop maps, traverses, and route maps.

**Unit-2: Field Techniques and Map Construction**

Use of compass clinometer and GPS in field mapping.

Techniques of mapping igneous, sedimentary, and metamorphic terrains.

Structural data plotting and interpretation.

Preparation of geological cross-sections and profiles.

Legend, color conventions, and preparation of fair copy geological maps.

**Unit-3: Remote Sensing Fundamentals**

Definition and principles of remote sensing.

Electromagnetic spectrum and interaction with Earth's surface.

Types of remote sensing: Active and Passive

Aerial photographs: types, scale and photo interpretation keys.

Satellite sensors and data products.

**Unit-4: Digital Image Processing and GIS**

Digital image formats and resolutions.

Image processing and enhancement: contrast stretching, filtering, enhancement.

Image classification: supervised and unsupervised.

Introduction to GIS: concept, data types (raster & vector), layers, and attributes.

Integration of geological and remote sensing data in GIS environment.

**Unit-5: Applications of Mapping and Image Processing**

Geological Mapping Using Remote Sensing and GIS: Lithological, Structural, and Geomorphological Mapping from Satellite Imagery.

Mineral and hydrogeological exploration using image interpretation.

Lineament and drainage analysis using GIS tools.

Recent advancements: UAV (drone) mapping, digital field mapping apps

**Books Recommended:**

1. Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2015). Remote Sensing and Image Interpretation. Wiley.
2. Drury, S.A. (2001). Image Interpretation in Geology. Nelson Thornes.
3. Sabins, F.F. (1996). Remote Sensing: Principles and Interpretation. Freeman.
4. McClay, K.R. (2011). Mapping of Geological Structures. Wiley-Blackwell.
5. Bonham-Carter, G. (1994). Geographic Information Systems for Geoscientists: Modelling with GIS. Pergamon.
6. Gupta, R.P. (2018). Remote Sensing Geology. Springer.

# Major Course – MJ 15: Practical IV

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To provide practical skills in ore mineral identification, reserve estimation, and exploration methods.

To develop field and laboratory techniques in hydrogeological and engineering geological investigations.

To apply geological mapping, remote sensing, and GIS tools for resource and hazard evaluation.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Identify ore minerals and estimate mineral reserves.

Interpret groundwater and engineering geological data.

Use remote sensing and GIS tools for geological and resource mapping.

Prepare professional-quality maps, reports, and interpretations for applied geology fields.

**Practical Content:**

Megascopic identification of ore minerals.

Study of microscopic properties of ore-forming minerals.

Preparation of maps: Distribution of essential ores and other economic minerals in India.

Computation of reservoir area, catchment area, reservoir capacity, and reservoir life.

Computation of index properties of rocks; computation of R.Q.D., R.S.R., R.M.R., and 'Q' values.

Plotting of major dams and tunnels on the outline map of India.

Study of seismic and landslide zones of India.

Preparation and interpretation of water-level contour maps and depth-to-water-level maps.

Map study of water potential zones of India.

Graphical representation of chemical quality data and water classification.

Simple numerical problems related to determining permeability in the field and laboratory, groundwater flow, and well hydraulics.

Aerial photo/imagery interpretation: identification of sedimentary, igneous, and metamorphic rocks.

Identification of geomorphic and structural features in aerial photo/satellite imagery.

Plane table / prismatic compass survey.

Identification of geophysical anomalies.

Concept of weighted average in anomaly detection.

Study of geological cross-sections of essential mineral deposits.

**Fieldwork:**

Geological mapping of two weeks' duration in a geologically complex area, followed by submission of a Field Work Report based on the survey.

**Books Recommended:**

1. Sen, A. K. Laboratory Manual of Geology. Modern Book Agency Pvt. Ltd., Calcutta.
2. Singh, R. P. (1965). Structural Geology: A Practical Approach. Ganga Kaveri Publication House, Varanasi, 133 pp.
3. Bennison, G. M. (1990). An Introduction to Geological Structures and Maps. 5th Edition, Edward Arnold, London, 67 pp.

# Semester VII

## Major Course – MJ 16: Fossil Fuel Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the origin, occurrence, classification, and distribution of fossil fuels.

To study the geological and geochemical processes involved in coal and petroleum formation.

To learn techniques of exploration, evaluation, and sustainable utilization of fossil fuel resources.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Explain the processes of formation and accumulation of fossil fuels.

Identify coal and petroleum reservoirs and understand their economic significance.

Interpret geological and geophysical data for fossil fuel exploration.

Assess environmental issues and sustainable practices related to fossil fuel extraction.

**Course Content:**

**Unit-1: Introduction to Fossil Fuels**

Definition and importance of fossil fuels: coal, petroleum, natural gas, shale hydrocarbons, tar sands.

Organic matter, source materials, and processes of fossil fuel generation.

World and Indian fossil fuel resources

Role of fossil fuels in the global energy mix and climate implications.

**Unit-2: Coal Geology**

Nature and composition of coal; peat, lignite, bituminous, and anthracite.

Rank, grade, and type of coal; proximate and ultimate analysis.

Origin of coal: biochemical and geochemical theories.

Coal petrography: macerals, microlithotypes, and vitrinite reflectance.

Mode of occurrence and structures in coal

Major coalfields of India.

**Unit-3: Petroleum Geology**

Composition and properties of crude oil and natural gas.

Origin of petroleum: organic and inorganic theories, kerogen types.

Migration and accumulation of petroleum — primary and secondary migration.

Reservoir rocks, cap rocks, and structural/stratigraphic traps.

Reservoir parameters: porosity, permeability, and saturation.

Petroliferous basins of India.

**Unit-4: Exploration and Production Techniques**

Geological and geophysical methods of exploration: seismic, gravity, magnetic, and geochemical surveys.

Drilling operations: rotary drilling, well logging, and coring techniques.

Subsurface mapping and preparation of structure contour maps.

Reserve estimation.

Unconventional energy resources: shale gas, coal bed methane (CBM), gas hydrates, and tar sands.

**Unit-5: Environmental and Economic Aspects**

Environmental impacts of coal, petroleum, and natural gas development

Acid mine drainage (AMD) and mine waste management

Fly ash utilization and mine overburden recycling

Reclamation of abandoned mines

Land degradation and landscape restoration in mining areas

Role of fossil fuels in global carbon cycle

National Clean Energy Policy & India's Net-Zero Roadmap (2070)

Regulatory framework: CPCB, MoEF&CC, PESO, DGMS



**Recommended Books:**

1. Tissot, B.P. & Welte, D.H. (1984). Petroleum Formation and Occurrence. Springer-Verlag.
2. Levorsen, A.I. (1967). Geology of Petroleum. W.H. Freeman.
3. Stach, E. et al. (1982). Stach's Textbook of Coal Petrology. Gebrüder Borntraeger.
4. Bordia, S.K. & Acharya, S.K. (2005). Coal and Petroleum Geology of India. Allied

# Major Course – MJ 17:

# Geotectonics and Applied Structural Geology

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand large-scale Earth structures and the dynamics of lithospheric plates.

To integrate principles of structural geology with geotectonic frameworks.

To apply structural analysis in exploration, regional mapping, and geotechnical studies.

**Course Learning Outcomes:**

After successful completion, students will be able to:

Interpret large-scale Earth structures within a plate tectonic framework.

Analyze complex structural patterns and their relation to tectonic evolution.

Apply structural data to exploration, mapping, and engineering site evaluation.

Understand India's major tectonic provinces and their economic significance.

**Course Content:**

**Unit-1: Fundamentals of Geotectonics**

Introduction to geotectonics.

Earth's internal structure and its geophysical evidence.

Continental drift (Wegener's hypothesis) and sea-floor spreading.

Concept of lithosphere and asthenosphere.

Plate tectonic theory — types of plate boundaries and plate interactions.

Earthquake belts, volcanic arcs, island arcs, and mid-ocean ridges.

**Unit-2: Crustal Movements and Orogeny**

Concept of orogeny and epeirogeny.

Geosynclinal theory and its modern reinterpretation.

Mountain building processes — subduction, collision, and accretion.

Tectonic evolution of the Himalaya and Indian shield.

Tectonic provinces of India — Dharwar, Singhbhum, Aravalli, Satpura, Himalaya.

Tectonic controls on mineralization and basin evolution.

**Unit-3: Advanced Structural Geometry and Analysis**

Fold and fault geometry in three dimensions — classification and mechanics.

Joints, shear zones, and fracture systems.

Stress and strain in rocks — strain ellipse, finite and infinitesimal strain.

Stereographic projection methods (conceptual).

Structural analysis of complex terranes — refolded folds, interference patterns, and superposed deformation.

**Unit-4: Applied Structural Geology**

Structural mapping and analysis from outcrop to regional scale.

Interpretation of geological and structural maps for mineral, hydrocarbon, and groundwater exploration.

Structural aspects in engineering geology — dam sites, tunnels, slopes, and foundations.

Application of remote sensing and GIS in structural interpretation.

Field techniques in structural mapping and stereonet plotting.

**Unit-5: Global and Regional Tectonic Frameworks**

Tectonic setting of oceanic and continental crust.

Rift basins, passive margins, and collision zones.

Intracratonic basins of India and their tectonic significance.

Plate reconstructions through time — supercontinents (Rodinia, Gondwana, Pangaea).

Mantle plumes, hotspots, and their geological expressions.

**Recommended Books:**

1. Billings, M.P. (1972). Structural Geology. Prentice Hall.
2. Park, R.G. (1997). Foundations of Structural Geology. Chapman & Hall.
3. Condie, K.C. (1989). Plate Tectonics and Crustal Evolution. Pergamon.
4. Twiss, R.J. & Moores, E.M. (2007). Structural Geology. W.H. Freeman.
5. Valdiya, K.S. (2010). The Making of India: Geodynamic Evolution. Macmillan.
6. Mukherjee, S. (2013). Structural Geology and Tectonics of the Indian Crust. Springer.

# Major Course – MJ 18: Practical V

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To train students in the identification and analysis of fossil fuel materials (coal and petroleum).

To develop skills in interpretation of subsurface data, well logs, and reservoir structures.

To provide hands-on practice in tectonic and structural interpretation of maps, sections, and imagery.

**Course Learning Outcomes:**

After completion, students will be able to:

Identify and classify coal and petroleum samples.

Correlate borehole data and construct geological/reservoir maps.

Interpret subsurface structures and traps using map and log data.

Apply structural and tectonic understanding to exploration and site analysis.

Prepare professional geological diagrams and reports.

**Practical Content:**

Locate different petroliferous basins and coalfields on the outline map of India.

Reserve estimation for coal.

Identification of different coal samples in hand specimen.

Preparation of lithologs based on borehole data supplied.

Introduction to Geological Maps: Lithological and Structural Maps.

Structural contouring and 3-point problems of dip and strike.

Drawing profile sections and interpreting geological maps of different complexities.

Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

**Fieldwork:**

Geological mapping of one-week duration in a geologically complex area and Field Work Report based on it.

**Recommended Books:**


1. Tissot, B.P. & Welte, D.H. (1984). Petroleum Formation and Occurrence. Springer.
2. Levorsen, A.I. (1967). Geology of Petroleum. W.H. Freeman.
3. Stach, E. et al. (1982). Stach's Textbook of Coal Petrology. Borntraeger.
4. Billings, M.P. (1972). Structural Geology. Prentice Hall.
5. Twiss, R.J. & Moores, E.M. (2007). Structural Geology. W.H. Freeman.
6. Condie, K.C. (1989). Plate Tectonics and Crustal Evolution. Pergamon.
7. Valdiya, K.S. (2010). The Making of India: Geodynamic Evolution. Macmillan.

# Advanced Major Course – AMJ 1: Geomorphology and RS-GIS in Geology (Only for Major / Honours)

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To introduce students to landform development and geomorphic processes.

To understand applications of geomorphology in geological and environmental studies.

To develop basic competence in Remote Sensing (RS) and Geographic Information System (GIS) techniques used in geological mapping, resource analysis, and hazard studies.

**Course Learning Outcomes:**

After completion of this course, students will be able to:

Identify and interpret landforms produced by various geomorphic processes.

Use remote sensing data for geological and geomorphological mapping.

Handle and analyze spatial data in GIS environment.

Apply RS–GIS techniques in resource and hazard studies.

**Course Content:**

**Unit-1: Introduction to Geomorphology**

Definition, scope, and significance of geomorphology in geology.

Landform Development: Structure, process, and stage — fundamental concepts of Davis, Penck, and Hack.

Weathering, mass wasting, and erosion — geomorphic agents and processes.

Factors controlling landform development: lithology, structure, and climate.

**Unit-2: Geomorphic Processes and Landforms**

Fluvial landforms: Processes, erosional and depositional landforms.

Aeolian landforms: Processes, erosional and depositional landforms.

Glacial and periglacial landforms: Processes, erosional and depositional landforms.

Coastal and marine landforms: Processes, erosional and depositional landforms.

Karst topography: Processes, erosional and depositional landforms.

Applied geomorphology — land use planning, drainage basin analysis, and hazard mitigation.

**Unit-3: Fundamentals of Remote Sensing**

Definition, principles, and components of remote sensing.

Electromagnetic spectrum and interaction with Earth's surface.

Types of sensors: optical, microwave, and thermal.

Platforms: aerial, satellite, and UAV (drone).

Satellite data products: Landsat, Sentinel, IRS, ASTER.

Basics of photogrammetry.

**Unit-4: Digital Image Interpretation and Analysis**

Image characteristics: tone, texture, shape, pattern, association.

Visual interpretation of lithology, structures, and landforms.

Digital image processing — enhancement, filtering, classification (supervised & unsupervised).

Extraction of lineaments, drainage, and geomorphic features.

Application of RS in geological and geomorphological mapping.

**Unit-5: Geographic Information System (GIS) and Applications**

Definition, concept, and components of GIS.

Data types: raster and vector; attributes and topology.

Coordinate systems, projections, and georeferencing.

Spatial data analysis and overlay operations.

Geological and geomorphological applications:

Groundwater potential mapping

Landslide susceptibility mapping

Introduction to QGIS / ArcGIS interface and tools.

**Books Recommended:**


1. Thornbury, W.D. (1969). Principles of Geomorphology. Wiley.
2. Summerfield, M.A. (1991). Global Geomorphology. Longman.
3. Drury, S.A. (2001). Image Interpretation in Geology. Nelson Thornes.
4. Lillesand, T.M., Kiefer, R.W., & Chipman, J.W. (2015). Remote Sensing and Image Interpretation. Wiley.
5. Heywood, I., Cornelius, S., & Carver, S. (2011). An Introduction to Geographical Information Systems. Pearson.
6. Gupta, R.P. (2018). Remote Sensing Geology. Springer.
7. Huggett, R.J. (2016). Fundamentals of Geomorphology. Routledge.

# RC – 1:

# Research Planning and Techniques

# (Only for Major / Honours with Research)

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To develop understanding of research design, planning, and execution.

To familiarize students with modern techniques, instruments, and data analysis in Earth Sciences.

To prepare students for dissertation writing, project proposals, and scientific communication.

**Course Learning Outcomes:**

After completion of this course, students will be able to:

Design and plan geological research effectively.

Collect, analyze, and interpret geological and environmental data.

Use basic analytical, statistical, and GIS tools for research.

Prepare professional reports, project proposals, and publications.

**Course Content:**

**Unit-1: Introduction to Research Methodology**

Meaning, objectives, and types of research — basic, applied, and exploratory.

Characteristics of scientific research; research ethics and plagiarism.

Steps in the research process — problem identification, formulation, and review of literature.

Concept of hypothesis and theory; research questions and objectives.

Role of research in geological and environmental studies.

**Unit-2: Research Design and Planning**

Research design: definition, need, and types (descriptive, analytical, experimental, case study).

Sampling techniques — random, stratified, and systematic sampling.

Field data collection methods: geological mapping, sampling of rocks, soils, and water.

Instrumentation planning: GPS, compass-clinometer, resistivity meter, and laboratory

instruments.

Scheduling, budgeting, and time management in research.

**Unit-3: Data Collection and Analytical Techniques**

Primary and secondary data sources in geology.

Quantitative and qualitative data types.

Geostatistical techniques: mean, median, standard deviation, correlation, and regression.

Graphical representation — histograms, ternary plots, rose diagrams, and stereonets.

**Unit-4: Remote Sensing, GIS, and Modelling Tools in Research**

Role of Remote Sensing and GIS in geological research.

Digital data handling and database creation.

Spatial data analysis and thematic mapping using GIS.

Remote Sensing based modelling and Software tools commonly used in geosciences.

**Unit-5: Report Writing, Presentation, and Publication**

Structure of scientific reports and dissertations.

Writing abstracts, research proposals, and funding applications.

Reference management tools: Zotero, Mendeley, EndNote.

Citation styles: APA, Harvard, and GSI formats.

Preparing figures, tables, and maps for publication.

Peer review and publication ethics.

**Books Recommended:**

1. Kothari, C.R. (2014). Research Methodology: Methods and Techniques. New Age International.
2. Davis, J.C. (2002). Statistics and Data Analysis in Geology. Wiley.
3. Fink, A. (2010). Conducting Research Literature Reviews. Sage.
4. Gupta, R.P. (2018). Remote Sensing Geology. Springer.
5. Hofmann, M., & Tierney, B. (2019). Research Design in Geosciences. Elsevier.

# Semester VIII

## Major Course – MJ 19:

## Advance Crystallography

## and Descriptive Mineralogy

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To deepen understanding of crystal structure, symmetry, and classification.

To explain the physical, chemical, and optical properties of major mineral groups.

To familiarize students with crystallographic methods, X-ray diffraction, and modern mineral characterization techniques.

To link mineralogy with petrogenesis and economic applications.

**Course Learning Outcomes:**

After completion of this course, students will be able to:

Identify and describe crystal systems, symmetry, and structures.

Relate crystal chemistry to physical and optical properties.

Classify and identify silicate and non-silicate minerals.

Understand modern techniques for crystal structure determination.

Apply mineralogical knowledge in petrology, geochemistry, and resource studies

**Course Content:**

**Unit-1: Crystal Symmetry and Systems**

Concept of crystal lattice, unit cell, and crystal axes.

Laws of crystallography — constancy of interfacial angles, symmetry, rational indices.

Symmetry elements: plane, axis, and center of symmetry.

Classification of crystal systems – isometric, tetrahedral, octahedral, monoclinic, triclinic, hexagonal and trigonal.

Bravais lattices — 14 types and their significance.

Projection diagrams and stereographic representation of crystals.

**Unit-2: Advanced Concepts in Crystallography**

Miller and Weiss indices, zone and zone law.

Crystal forms, combination of forms, and crystal morphology.

Twinning in crystals — laws, types, and examples.

Polymorphism and pseudomorphism.

Principles of crystal growth and defects in crystals.

Introduction to crystal structure determination methods — X-ray diffraction (XRD), electron diffraction, and neutron diffraction.

**Unit-3: Crystal Chemistry and Bonding**

Types of atomic bonding in minerals: ionic, covalent, metallic, and van der Waals.

Coordination number and radius ratio. Isomorphism and solid solution.

Structural classification of silicates — nesosilicates, sorosilicates, cyclosilicates, inosilicates, phyllosilicates, and tectosilicates.

Pauling's rules of crystal structure.

**Unit-4: Descriptive Mineralogy – Silicate Groups**

Olivine group — composition, structure, and alteration.

Pyroxene group — clinopyroxene and orthopyroxene classification.

Amphibole group — structure and identification.

Mica group — biotite and muscovite characteristics.

Feldspar group — alkali and plagioclase series, twinning, and phase relations.

Feldspathoid group — nepheline, leucite, and sodalite.

Quartz and silica minerals — polymorphs and transformation.

**Unit-5: Non-Silicate and Accessory Minerals**

Oxides and hydroxides: hematite, magnetite, corundum, bauxite.

Sulphides and sulphates: pyrite, galena, chalcopyrite, gypsum, barite.

Carbonates and phosphates: calcite, dolomite, apatite.

Native elements: gold, copper, sulfur, graphite.

Gem minerals and industrial minerals — classification and identification.

Optical properties (overview) and physical identification of key minerals in hand specimen.

**Books Recommended:**


1. Dana, J.D. & Ford, W.E. (2001). A Textbook of Mineralogy. Wiley Eastern.
2. Klein, C., & Dutrow, B. (2012). Manual of Mineral Science (after Dana). Wiley.
3. Mason, B. & Berry, L.G. (2014). Elements of Mineralogy. W.H. Freeman.
4. Nesse, W.D. (2017). Introduction to Mineralogy. Oxford University Press.
5. Deer, W.A., Howie, R.A., & Zussman, J. (1992). Rock-forming Minerals. Longman.
6. Phillips, F.C. (1956). An Introduction to Crystallography. Longmans.
7. Smart, J.S. (1977). Solid State Chemistry: An Introduction. Chapman & Hall.

# Major Course – MJ 20: Practical VI

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To provide practical understanding of crystal forms, systems, and symmetry elements.

To train students in physical and optical identification of minerals.

To introduce modern tools such as X-ray diffraction and thin-section mineral identification.

To relate mineral properties with their geological significance and field occurrences.

**Course Learning Outcomes:**

After completing this practical course, students will be able to:

Identify and classify crystal forms and symmetry elements accurately.

Recognize and describe common silicate and non-silicate minerals in hand specimen.

Understand optical properties and use of basic laboratory instruments.

Relate mineral physical properties to their crystal chemistry and geological occurrence

Develop skills in systematic mineral description and record preparation.

**Practical Content:**

Observation and documentation of the symmetry of crystals.

Study of symmetry elements in crystal models belonging to the seven crystal systems.

Determination of crystal axes, axial ratios, and interfacial angles using models.

Measurement of crystal angles with a contact goniometer.

Clinographic and stereographic projection of crystals.

Study of physical properties of minerals in hand specimen: Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite,

Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite, Quartzvarieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.

Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.

Study of some essential silicate minerals under an optical microscope and their characteristic properties.

**Fieldwork:**

Geological mapping of one-week duration in a geologically complex area and Field Work Report based on it.

**Books Recommended:**

1. Kerr, P.F. (1977). Optical Mineralogy. McGraw Hill.
2. Nesse, W.D. (2017). Introduction to Optical Mineralogy. Oxford University Press.
3. Klein, C. & Dutrow, B. (2012). Manual of Mineral Science (after Dana). Wiley.
4. Mason, B. & Berry, L.G. (2014). Elements of Mineralogy. W.H. Freeman.
5. Phillips, F.C. (1956). An Introduction to Crystallography. Longmans.
6. Deer, Howie & Zussman (1992). Rock Forming Minerals, Vol. 1–5. Longman.

# Advanced Major Course – AMJ 2:

# Geochemistry and Advance Petrology

# (Only for Major / Honours)

**Marks Distribution: 25 (5 – Attendance + 20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs) = 100**

**Pass Marks: Th (SIE + ESE) = 40**

**(Credits: Theory – 04) / 60 Hours**

**Course Objectives:**

To understand the chemical composition and processes of the Earth and its components.

To learn the geochemical behavior of elements and isotopes in geological environments.

To study petrogenetic processes and classification of igneous, sedimentary, and metamorphic rocks.

To develop advanced understanding of rock-forming processes through geochemical modeling.

**Course Learning Outcomes:**

After completion of this course, students will be able to:

Explain the chemical composition and evolution of the Earth.

Analyze the behavior of elements and isotopes in geological systems.

Interpret geochemical data in relation to igneous, sedimentary, and metamorphic processes.

Apply geochemical principles in exploration and environmental studies.

**Course Content:**

**Unit-1: Fundamentals of Geochemistry**

Scope and importance of geochemistry in Earth sciences.

Composition of the Earth: crust, mantle, and core.

Cosmic abundance of elements and Goldschmidt's classification.

Chemical differentiation of the Earth and geochemical cycles.

Meteorites and their significance in understanding Earth's composition.

**Unit-2: Element Behavior and Geochemical Processes**

Geochemical classification of elements — lithophile, siderophile, chalcophile, atmophile.

Partition coefficients and trace element geochemistry.

Isotope geochemistry: stable and radiogenic isotopes (C, O, S, Sr, Pb, U–Th–Pb systems).

Radiometric dating methods and their geological applications.

Geochemical reservoirs and mass balance equations.

Role of fluids in geochemical differentiation.

**Unit-3: Advanced Igneous Petrology**

Magma generation — partial melting, magma differentiation, and assimilation.

Phase rule and its application to igneous systems.

Bowen's reaction series and its petrogenetic implications.

Classification of igneous rocks — chemical (TAS) and normative (CIPW) systems.

Major igneous rock suites: basaltic, granitic, and ultramafic associations.

Geochemical variation diagrams (Harker, AFM, and spider diagrams).

Tectonic setting discrimination using major and trace element geochemistry.

**Unit-4: Sedimentary and Metamorphic Petrology**

Weathering and sediment composition — geochemical mobility and index of alteration.

Diagenesis and geochemical transformation in sedimentary basins.

Classification of sedimentary rocks based on chemical composition.

Metamorphism — progressive and retrograde reactions, mineral stability.

Phase rule in metamorphic systems and chemographic diagrams (ACF, AKF, AFM).

Metamorphic facies, grades, and P–T paths.

Geochemistry of metamorphic fluids and mass transfer.

**Unit-5: Applied and Environmental Geochemistry**

Geochemical exploration for ore deposits — pathfinder elements and anomalies.

Hydrogeochemical and biogeochemical prospecting methods.

Environmental geochemistry — pollution indicators and elemental contamination.

Geochemical cycles of carbon, nitrogen, and sulfur.

Soil and water geochemistry; anthropogenic effects and remediation.

Use of isotopes in environmental and hydrological studies.

**Books Recommended:**


1. Mason, B. & Moore, C.B. (1982). Principles of Geochemistry. Wiley.
2. Rollinson, H.R. (1993). Using Geochemical Data: Evaluation, Presentation, and Interpretation. Longman.
3. Faure, G. (1998). Principles and Applications of Geochemistry. Prentice Hall.
4. Winter, J.D. (2014). Principles of Igneous and Metamorphic Petrology. Pearson.
5. Philpotts, A.R. & Ague, J. (2009). Principles of Igneous and Metamorphic Petrology. Cambridge.
6. Best, M.G. (2002). Igneous and Metamorphic Petrology. Wiley Blackwell.
7. Krauskopf, K.B. & Bird, D.K. (1995). Introduction to Geochemistry. McGraw-Hill.
8. Goldschmidt, V.M. (1954). Geochemistry. Oxford University Press.

# Advanced Major Course – AMJ 3: Practical VII

**Marks Distribution: = 100 (ESE)**

**Pass Marks = 40**

**(Credits: Theory – 04) / 120 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 60 marks
- Practical record: 15marks
- Viva-voce: 25 marks

**Course Objectives:**

To train students in basic and applied geochemical calculations and rock classification.

To interpret igneous, sedimentary, and metamorphic rock data using graphical and computational methods.

To develop skills in mineral–rock identification, thin-section petrography, and geochemical plotting.

To introduce the use of digital tools for petrological and geochemical analysis.

**Course Learning Outcomes:**

After completion of this course, students will be able to:

Perform geochemical calculations and rock classification from chemical data.

Identify common igneous, sedimentary, and metamorphic rocks in hand specimen and thin section.

Construct and interpret geochemical diagrams for petrogenetic analysis.

Utilize digital tools for visualization and interpretation of geological datasets.

Integrate field, laboratory, and computational approaches in petrological studies.

**Practical Content:**

Megascopic study of sedimentary structures.

Particle size distribution and statistical treatment.

Palaeocurrent analysis.

Petrography of clastic and non-clastic rocks through hand specimens and thin sections.

Study of important igneous rocks in hand specimens and thin sections.

Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks,

Graphic plots for petrochemistry and interpretation of assemblages: ACF and AKF diagrams.

**Fieldwork:**

Geological mapping of one-week duration in a geologically complex area and Field Work Report based on it.

**Books Recommended:**


1. Rollinson, H.R. (1993). Using Geochemical Data. Longman.
2. Winter, J.D. (2014). Principles of Igneous and Metamorphic Petrology. Pearson.
3. Best, M.G. (2002). Igneous and Metamorphic Petrology. Wiley Blackwell.
4. Philpotts, A.R. & Ague, J. (2009). Principles of Igneous and Metamorphic Petrology. Cambridge.
5. Krauskopf, K.B. & Bird, D.K. (1995). Introduction to Geochemistry. McGraw-Hill.
6. Mason, B. & Moore, C.B. (1982). Principles of Geochemistry. Wiley.
7. Nesse, W.D. (2017). Introduction to Optical Mineralogy. Oxford University Press.

# RC – 2:

# Project Dissertation / Research Internship / Field Work

# (Only for Major / Honours with Research)

**Marks = 200**

**(Credits: Theory – 08)**

**Course Objectives:**

To train students in designing and executing independent geological research or field studies.

To develop critical thinking, data interpretation, and scientific report-writing skills.

To provide exposure to professional or industrial research environments.

To strengthen field-based observational and mapping abilities.

**Course Options:**

Students can choose any one of the following modes based on departmental availability and interest:

1. Project Dissertation (Laboratory / Theoretical / Analytical Study)
2. Research Internship (University, Research Institute, or Industry)
3. Field Work Report (Field Mapping / Survey / Data Collection Based)

**Option 1: Project Dissertation**

Topic selection and approval by the Department / Supervisor.

Review of literature and formulation of objectives.

Methodology: sampling, analysis, mapping, or computational study.

Data analysis, interpretation, and graphical representation.

Report writing and presentation.

**Suggested Project Areas**

Petrology, Mineralogy, Geochemistry, Stratigraphy

Structural and Field Geology

Hydrogeology, Engineering Geology, and Environmental Geology

Economic Geology and Ore Prospecting

Remote Sensing and GIS applications

Groundwater or soil quality studies

Environmental impact assessment of mining or land use

**Option 2: Research Internship**

Minimum 4–6 weeks placement in a recognized geological organization / university / industry, such as:

GSI, ONGC, CIMFR, NGRI, AMD, MECL, IITs, ISM Dhanbad, or State DGM.

Work under guidance of an external mentor and internal faculty supervisor.

Maintenance of internship diary documenting daily/weekly tasks.

Submission of internship report summarizing work, techniques, and outcomes.

Viva-voce presentation based on experience and learning outcomes.

**Option 3: Field Work Report**

Minimum 10–15 days of geological field training.

Mapping of lithology, structure, stratigraphy, and geomorphology of selected area.

Collection of rock, fossil, and structural data.

**Preparation of:**

Geological map (with legend and cross-section)

Stratigraphic column and lithologs.

Structural data plots (stereonet / rose diagram).

Report including methodology, observations, interpretation, and conclusion.

**Expected Learning Outcomes**

After completing this course, students will be able to:

Design and conduct independent geological investigations.

Collect, analyze, and interpret geological or geochemical data.

Prepare scientific reports and communicate findings effectively.

Apply modern analytical, field, or computational techniques in Geology.

Develop teamwork, leadership, and professional research ethics.

**Format of Final Report / Dissertation:**

1. Title Page and Certificate
2. Abstract (150–250 words)
3. Acknowledgement
4. Table of Content
5. Introduction and Objectives
6. Study Area / Background
7. Methodology
8. Results and Discussion
9. Conclusion and Future Scope
10. References (APA or GSI format)
11. Appendices (if any — maps, photos, data tables, etc.)

**Suggested Reading & Reference Materials:**


1. Gill, R. (2015). Geochemical Analysis of Rocks and Minerals.
2. Compton, R.R. (1985). Geology in the Field. Wiley.
3. Krauskopf, K.B. & Bird, D.K. (1995). Introduction to Geochemistry.
4. Mukerji, S. (2019). Practical Field Geology. CBS Publishers.
5. Keller, E.A. (2018). Environmental Geology.
6. Remote Sensing and GIS Manuals (ISRO/NRSC).

# Courses of Study in FYUGP Geology Minor

# Associated Course – MN A: Introductory Geology

**Marks Distribution: 15 (5 – Attendance + 10 SIE: 1 Hr.) + 60 (ESE: 3 Hrs) = 75**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To provide a fundamental understanding of Geology; Earth in the solar system along with its components and various processes, concepts of energy resources and engineering geology; basic understanding of minerals and rocks; the evolution of life through geological time scale.

**Course Outcomes:**

After the completion of the course, the students will be able to:

Acquire the fundamental understanding of the Geology and its various branches; Earth and its components, thorough an understanding of materials (minerals, rocks and fossils), energy resources and processes of the earth, apply the knowledge of earth science to address societal issues.

**Course Content:**

**Unit-1:** Holistic understanding of dynamic planet 'Earth" through Geology, Introduction of various branches of Earth Sciences, Application of Geology in various fields.

**Unit-2:** Earth in Solar System: Origin, the internal constitution of the Earth: core, mantle, crust. Atmosphere and Hydrosphere, Physiographic division of India, Earthquake and volcano, Major engineering projects of India: Dam/Reservoir, Tunnel, Bridges.

**Unit-3:** Energy: Renewable and Non-renewable energy, alternate energy sources.

**Unit-4:** Mineral: Definition, Classification and physical properties.

Rocks: definition and types, and basics of formation

Igneous: Magma, their types, origin and composition, Igneous forms. Sedimentary: Weathering and Erosion, a process of formation, texture and structure, Metamorphic: agents and types of metamorphism, Metamorphic Structure.

**Unit-5:** Fossils and their application: Definition, processes, modes of preservation and uses, application of fossils.

**Books Recommended:**


1. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
3. Lutgens, F., Tarbuck, E., and Tasa, D., (2009). The Atmosphere: An Introduction to Meteorology. Pearson Publisher
4. Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.
5. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
6. Waltham, T., (2009). Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
7. Bateman, A.M. and Jensen, M.L. (1990). Economic Mineral Deposits. John Wiley.
8. Gokhale, K.V.G.K. and Rao, T.C. (1978). Ore deposits of India their distribution and processing, Tata McGraw Hill, New Delhi
9. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.
10. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company, New York.
11. Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold
12. Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill.

# Associated Course: MN A Practical

**Marks Distribution: = 25 (ESE)**

**Pass Marks = 10**

**(Credits: Theory – 01) / 30 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 15 marks
- Practical record: 05 marks
- Viva-voce: 05 marks

**Practical Content:**

Distribution of Seismic zone in India

Locate the major engineering projects in India: Dam/Reservoir, Tunnel, Bridges.

Physiographic division of India

Distribution of renewable and non-renewable energy sources of India

Megascopic study of physical properties of important rock forming minerals

Megascopic study of Invertebrate fossils.

Megascopic study of Plant fossils.

# Minor Course – MN B: Essentials of Geology, Rocks and Minerals

**Marks Distribution: 15 (5 – Attendance + 10 SIE: 1 Hr.) + 60 (ESE: 3 Hrs) = 75**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To provide a fundamental understanding of the Earth in the solar system along with its origin, age, and its internal structure; various physical processes; concepts of plate tectonics; concepts of minerals, fossils, and rocks and its different types.

**Course Outcomes:**

After successful completion of the course, the students are expected to:

Acquire the fundamental understanding of the Earth and its components, thorough an understanding of materials such as minerals, fossils and rocks and processes of the earth surface such as earthquake and volcanoes and apply the knowledge of earth science to address societal issues.

**Course Content:**

**Unit-1:** Introduction to Geology, scope, sub-disciplines, and relationship with other branches of Sciences, Earth in the solar system: Origin. Solar System- Introduction to Various planets- Terrestrial and Jovian Planets, Internal constitution of the Earth: core, mantle and crust.

**Unit-2:** Conventions in the Earth's core and production of the magnetic field; Earthquake: causes, effects and distribution; Volcanoes: types, products and distribution, Introduction to hydrosphere, biosphere and atmosphere; Origin of mountains; Elementary idea about Plate Tectonics.

**Unit-3:** Age of the Earth: Radioactivity and its application in determining the age of the Earth. Basic concept of:

a) Rocks: types with examples
b) Minerals: Definition and Classification.
c) Fossils: mode of preservation and uses

**Unit-4:** Minerals: Definitions, Classification and Physical properties of minerals. Silicate Structure. Nature of light and principles of optical mineralogy. Classification of minerals based on optical properties; Petrological Microscope.; Optical properties of minerals – pleochroism, interference colour, extinction.

**Unit-5:** Rocks: Definitions and types, Basics of rock formation.
Igneous rock: texture and Structure, magma: Origin and Composition.
Sedimentary rocks: the process of formation, texture and Structure. Metamorphic rocks: Agents and types of metamorphism, texture and Structure.

**Books Recommended:**

Holme's Principles of Physical Geology (1992). Chapman & Hall
Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.
Gross, M.G. (1977). Oceanography: A view of the Earth, Prentice Hall.
Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.
Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company, New York.

# Minor Course: MN B Practical

**Marks Distribution: = 25 (ESE)**

**Pass Marks = 10**

**(Credits: Theory – 01) / 30 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 15 marks
- Practical record: 05 marks
- Viva-voce: 05 marks

**Practical Content:**

Physical properties of minerals: Study and Documentation.

Study of physical properties of important rock-forming minerals in hand specimen:

Plotting of major Dams on the outline map of India, mention the name of the river and utility of the dam.

Study of Seismic Zones of India.

Observation and documentation of forms of igneous rocks.

Study of optical properties of minerals.

Study of rocks in hand specimens.

# Minor Course – MN C: Earth Resources

**Marks Distribution: 15 (5 – Attendance + 10 SIE: 1 Hr.) + 60 (ESE: 3 Hrs) = 75**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To understand the concept of earth resources; Ore minerals; its types, genesis, and occurrences, components and classification; knowledge of energy resources and its different types; groundwater resources and its management.

**Course Learning Outcomes:**

After successful completion of the course, the students are expected to have the knowledge of mineral, energy and groundwater resources, their various components, and their uses providing benefits to the society.

**Course Content:**

**Unit 1:**

Earth Resources: Definition: Mineral, Ore and Gangue, Tenor, Grade. Introduction to Essential, Critical and Strategic Minerals. A brief overview of the Classification of Mineral deposits concerning processes of formation and mode of occurrences.

**Unit 2:**

Definition of Energy: Primary and Secondary Energy. Renewable and Non-Renewable Sources of Energy. Environmental Dimension of Energy.

**Unit 3:**

Major Types and Sources of Energy: Resources of Natural Oil and Gas. Coal and Nuclear Minerals: Types and distribution. Introduction to Hydroelectric Power, Solar Energy, Wind, Wave and Biomass-based Power and Energy.

**Unit 4:**

Groundwater resources and their management, Groundwater resources and their role in the economic development of a country. Rainwater harvesting and artificial recharge to groundwater. Watershed management.

**Unit 5:**

Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies.

**Books Recommended:**

Energy and the Environment by Fowler, J.M. (1984). McGraw-Hill Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.

Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M.A. Prelas. 2009, Springer

Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.

Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.

# Minor Course: MN C Practical

**Marks Distribution: = 25 (ESE)**

**Pass Marks = 10**

**(Credits: Theory – 01) / 30 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 15 marks
- Practical record: 05 marks
- Viva-voce: 05 marks

**Practical Content:**

Plotting of major Indian oil fields on the map of India.

Plotting of major Indian coalfields on the map of India/Jharkhand.

Plotting of natural hazards on the map of India.

Megascopic study of important ore forming minerals.

**Books Recommended:**

Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)

Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.

Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.

# Minor Course – MN D:

# Fossils and Their Applications

**Marks Distribution: 15 (5 – Attendance + 10 SIE: 1 Hr.) + 60 (ESE: 3 Hrs) = 75**

**Pass Marks: Th (SIE + ESE) = 30**

**(Credits: Theory – 03) / 45 Hours**

**Course Objectives:**

To study the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate, ecology and biogeography; also their application in geological field

**Course Outcomes:**

After the completion of the course, the student will be able to:

Understanding the evolution of life through time; knowledge of different fossil groups; appreciate how fossils provide the information on the paleoclimate, paleobiogeography, and paleoecology; application in hydrocarbon exploration, reservoirs correlations, pollution indicator etc.

**Course Content:**

**Unit 1:**

Introduction to fossils: Definition of fossil, fossilization processes, modes of fossil preservation and uses.

**Unit 2:**

Species concept: Definition of species, methods of description and naming of fossils.

**Unit 3:**

Introduction to various fossil groups, Brief Introduction of important fossil groups: morphology and geological history of Brachiopoda, Gastropod and lamellibranchia.

**Unit 4:**

Application of fossils: In the study of palaeoecology, paleobiogeography and palaeoclimate.

**Unit 5:**

The societal importance of fossils: implication of larger benthic and micropaleontology in hydrocarbon exploration: identification of reservoirs and their correlation. Application of spore

and pollens in the correlation of coal seams. Fossils as an indicator of pollution.

**Books Recommended:**

Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold.

Clarkson, E.N.K. (1998). Invertebrate Palaeontology and Evolution George Allen & Unwin

Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill.

Benton, M.J. (2005). Vertebrate palaeontology (3rd Edition). Blackwell Scientific, Oxford.

Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time, Edwin

H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

# Minor Course: MN D Practical

**Marks Distribution: = 25 (ESE)**

**Pass Marks = 10**

**(Credits: Theory – 01) / 30 Hours**

**Instruction to Question Setter for End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

- Experiment: 15 marks
- Practical record: 05 marks
- Viva-voce: 05 marks

**Practical Content:**

Study of fossils showing various modes of fossilization.

Distribution of diagnostic fossils in India.

Study of morphological characters of important Invertebrate fossils.

Drawing and labelling of various fossils.

**Books Recommended:**

Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)

Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.

Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.



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Dr. M. K. Saini

Shri Atul Beck

Mr. Vinod Kumar Tirkey

Dr. Somesh Sengupta

Dr. Melvin A. Ekka