ANNAMALAI UNIVERSITY

(Accredited with 'A+' Grade by NAAC)

M. Sc. GEOLOGY

(Two Year programme)

Regulation & Curriculum

2023 - 2024 onwards

DST-FIST Supported

DEPARTMENT OF EARTH SCIENCES

Annamalai University

Faculty of Science

DEPARTMENT OF EARTH SCIENCES
(DST-FIST Supported)

M. Sc. Geology (Two Year Programme)

(TANSCHE syllabus)

Programme Code: SEAR21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Geology** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science, M.Sc. Geology (Two Year) Regulations 2023**". They shall come into force with effect from the academic year 2023 – 2024.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Biochemistry is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures / Laboratory / Seminar / Project work / viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enablesa student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.12 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.13 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.14 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.15 **Course Objectives** are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student.

1.16 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.17 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.18 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters is given in section11.4.

1.19 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2 Programme Offered and Eligibility Criteria:

The Department of Earth Sciences offers a Two-Year M. Sc. Geology programme. A pass in Bachelor's Degree with Geology / Applied Geology as major subject and Mathemetics, Physics, Chemistry, Botany, Zoology or any other science subjects as two allied subjects accepted by the Syndicate of Annamalai University as equivalent thereto are eligible for admission.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programmes.

3. **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Discipline Centric/Generic), Project, Skill Enhancement Course, Internship/industrialvisit and extension activity.

5.2 Core courses

5.2.1 Core Course is mandatory and an essential requirement to qualify for the Degree.

5.2.2 These are a set of compulsory courses essential for each programme.

5.2.3 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Project

5.3.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.3.2 The Head of the Department shall assign a Research Supervisor to the student.

5.3.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.3.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor will be from the host institute.

5.4 Elective courses

5.4.1 Elective Course: Generic/Discipline Centric is a course that a student can choose from a range of alternatives.

5.5 Internship/Industrial Activity (Experiential Learning)

5.5.1 Experiential learning in the form of internship/industrial activity provides opportunities to students to connect principles of the discipline with real-life situations.

5.5.2 In-plant training/field trip/internship/industrial visit fall under this category.

5.5.3 Experiential learning is categorized as non-core course.

5.6 Industry/Entrepreneurship

This course is to introduce students to the activity of setting up a business or businesses taking on financial risks in the hope of profit.

5.7 Skill Enhancement Course: SEC is a course designed to provide value-based or skill-based knowledge.

5.7.1 The main purpose of this course is to provide students with skills in the hands-on mode to increase their employability.

5.8 Extension Activity The basic objective of extension activity is to create social awareness among the students by providing the opportunities to work with people and also to create an awareness and knowledge of social realities to have concernfor the welfare of the community and engage in creative and constructive societal development.

5.8.1 It is mandatory for every student to participate in extension activity.

5.8.2 All the students should enroll under NSS/NCC/CYRC/RRC or any other service organization in the University.

5.8.3 Students should put a minimum attendance of 40 hours in a year duly certified by the Programme Co-Ordinator.

5.8.4 Extension activity shall be conducted outside the class hours.

5.8.5 Extension activity is categorized as non-core course.

5.9 Value Added Course (VAC)

5.9.1 Students may opt to take Value Added Course beyond the minimum credits required for the award of the degree. VACs are outside the normal credit paradigm.

5.10 Online Courses

5.10.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.10.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.11 Credit Distribution: The credit distribution is organized as follows:

Component	Course	Credits
Part A	Core (Theory)	45
	Core (Practical)	12
	Project with Viva voce	07
Part B (i)	Elective (Generic/Discipline Centric)	18
Part B (ii)	Internship/Industrial Visit	02
Part B (iii)	Skill Enhancement Course/Professional Competency Skill	06
Part C	Extension Activity	01
	TOTAL CREDITS	91

Part A component and Part B (i) will be taken into account for CGPA calculation forthe post graduate programme and the other components of Part B and Part C will not be included for CGPA calculation and have to be completed during the duration of the programme as per norms, to be eligible for obtaining the PGdegree.

5.12 Credit Assignment

Each course is assigned credits and credit hours on the following basis:
1 Credit is defined as
1 Lecture period of one hour duration per week over a semester
1 Tutorial period of one hour duration per week over a semester
1 Practical / Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

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

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End- Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class test, assignments and seminars. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Tests will be for one- or two-hours duration depending on the quantum of syllabus.

8.4.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.4.6 For the CIA Tests, the assessment will be done by the Course teacher

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.6 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.7 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.2.2 For the Practical courses, the CIA Tests will carry 25% and the ESE 75% of the marks.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I and Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	10
Test-II	10
Viva-voce and Record	05
Total	25

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by internal examiners.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		**End Semester Examination(75 Marks)**	
Review-I - 10	Review-II -15	Project / Dissertation Evaluation	Viva voce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

11.4 CGPA is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

m is the number of semesters.

11.5 Evaluation:

11.5.1 Performance of the student for each course will be rated as shown in the Table.

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten-point rating scale is used for evaluation of the performance of the student toprovide overall grade for the Master's Programme.

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 For First Class with Distinction: Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **For First Class:** Candidates who have passed all the courses with a CGPA of 6.5and above.

11.6.3 **For Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the first appearance itself are eligible for University Rank.

11.6.5 Formula for Conversion of CGPA into Percentage

CGPA × 9.5 = Percentage

11.7 Course-Wise Letter Grades

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

11.7.2 A student is considered to have completed a course successfully and earned the creditsif he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point

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

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

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered forthe course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct: Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. Transitory Regulations: Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students toclear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as

per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two-Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

DEPARTMENT OF EARTH SCIENCES

M.Sc. GEOLOGY (TWO YEAR) PROGRAMME

PROGRAMME CODE: SEAR21

Curricula and Scheme of Examination

(For students admitted from the academic year 2023-2024)

List of Courses

Course Code	Course Title	Hours / Week		C	Marks		
		L	P		CIA	ESE	Total
Semester - I							
23GEOC101	Core I: Physical Geology and Geomorphology	5		5	25	75	100
23GEOC102	Core II: Mineralogy and Instrumentation Techniques	5		5	25	75	100
23GEOP103	Core III: Mineralogy and Paleontology Practical	10		4	25	75	100
23GEOE104	Elective – I Recent Trends in Paleontology	5		3	25	75	100
23GEOE105	Elective – II Stratigraphy of India and its Application	5		3	25	75	100
		30		**20**			**500**
Semester - II							
23GEOC201	Core IV: Structural Geology and Geotectonics	5		5	25	75	100
23GEOC202	Core V :Applied Remote Sensing and GIS	5		5	25	75	100
23GEOP203	Core VI: Structural Geology & Geotectonics and Petrology Practical	8		4	25	75	100
23GEOE204	Elective –III Applied Petrology (Mandatory)	4		3	25	75	100
23GEOE205	Elective – IV Environmental Earth Sciences	4		3	25	75	100
23GEOS206	Skill Enhancement Course [SEC] - I Introduction to Geological software	4		2	25	75	100
		30		**22**			**600**

Semester - III

23GEOC301	Core VII: Geophysics	6		5	25	75	100
23GEOC302	Core VIII: Hydrogeology	6		5	25	75	100
23GEOP303	Core IX: Geophysics Practical	6		5	25	75	100
23GEOP304	Core X : Applied Hydrogeology Practical	5		4	25	75	100
23GEOE305	Elective - V Economic Geology (Mandatory)	4		3	25	75	100
23GEOS306	Skill Enhancement course [SEC] – II Field studies written report and evaluation.	3		2	25	75	100
23GEOI307	Internship / Industrial Activity / Field mapping			2	25	75	100
		30		**26**			**700**

Semester - IV

23GEOC401	Core XI: Applied Geochemistry	6		5	25	75	100
23GEOC402	Core XII: Engineering and Mining Geology	6		5	25	75	100
23GEOD403	Project with viva voce	10		7	25	75	100
23GEOE404	Elective Paper VI / Petroleum Exploration and Mud logging (Industry / Entrepreneurship 20% Theory 80% Practical)	4		3	25	75	100
23GEOS405	Skill Enhancement Course [SEC] - III Professional competency skills / Geological tour	4	9	2	25	75	100
23GEOX406	Extension Activity NSS / NCC			1	25	75	100
		30		**23**			**600**
	Total Credits			**91**			**2400**

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

SEMESTER – 1: Physical Geology and Geomorphology (Ist year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC101	**Core I Physical Geology and Geomorphology**	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
CO1	To interpret natural processes which act on the Earth's surface and the landforms.
CO2	To recall the types of landforms and quaternary landscapes
CO3	To employ geomorphological studies for structural and mineral exploration
CO4	To understand the pedochemical process responsible for the dissolution rate.
CO5	To identify different processes involved different geological landforms.

UNIT	Details	No. of Hours	Course Objectives
I	Earth and its internal structure, composition, size and shape. An overview of plate tectonics including elementary concepts of plates, lithosphere, asthenosphere, types of plate boundaries and associated important geological features like oceanic trenches, volcanic arcs, accretionary wedges, topography of mid-ocean ridges and transform faults. Palaeomagnetism and its application for determining palaeoposition of continents. Isostasy, Orogeny and Epeirogeny.	12	CO1
II	Concepts of geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Earthquakes and related landscape alterations, Seismic belts of the earth. Seismicity at plate boundaries. Principles of Geodesy.	12	CO2
III	Geomorphic Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition.	12	CO3
IV	Geomorphic landforms – fluvial, glacial, aeolian, coastal, volcanoes and karst.	12	CO4
V	Quaternary landscapes. Fluvial landscapes, Aeolian landscapes, coastal landscapes.	12	CO5
	Total	**60**	

Text Books	
1.	Holmes, D.L. (1981) Principles of Physical Geology, ELBS Edition.
2.	Pethick, J. (1984) An Introduction to Coastal Geomorphology. Arnold, London.

3	Thornbury, W.D. (1969) Principles of Geomorphology. Wiley Eastern Ltd.
4	Richar Huggett, Fundamentals of Geomorphology
5	Strahler, A.N. (1952) Physical Geology. John Wiley & Sons Inc., New York.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Holmes, D.L. (1981) Principles of Physical Geology.ELBS Edition.
2.	Pethick, J. (1984) An Introduction to Coastal Geomorphology. Arnold, London.
3.	Thornbury, W.D. (1969) Principles of Geomorphology.Wiley Eastern Ltd.
4.	Richar Huggett, Fundamentals of Geomorphology
5.	Strahler, A.N. (1952) Physical Geology. John Wiley & Sons Inc., New York.
Web Resources	
1.	https://journals.sagepub.com/home/jom
2.	https://www.americangeosciences.org/
3.	https://www.egu.eu/
4.	https://www.geosociety.org/

Course outcome:

CO1: Basic knowledge about the internal structure of earth,
CO2: Students studied the plate tectonics theory.
CO3: Get knowledge about the Landform: exogenic and endogenic processes
CO4: Learn the Landform and tectonics Drainage pattern, sea level change and geomorphic cycle.
CO5: Students can introduce the basis of Quaternary landscapes.

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verbs used to describe your course outcome.

- **Remember and Understanding – Lower level**
- **Apply and Analyze – Medium Level**
- **Evaluate and Create – Strong Level**

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	3	3	3	2	3	3	3	2
CO 2	3	3	3	3	3	3	3	3
CO 3	3	2	3	3	3	3	3	1
CO 4	2	3	3	3	2	3	3	3
CO 5	3	3	2	3	3	3	3	3

S-Strong-3; M-Medium -2; L-Low-1.

Program Specific Outcomes

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- I: Mineralogy and Instrumentation Techniques (Ist year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC102	**Core II Mineralogy and Instrumentation Techniques**	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
CO1	The students will be able to understand and explain the basic of mineral characteristics.
CO2	Will be able to employ their practical knowledge in further studies.
CO3	Can recall techniques for certain necessities.
CO4	Can evaluate the accuracy and summaries the methods adapted for certain practical activities.
CO5	Can explain and summarise problem.

UNIT	Details	No. of Hours	Course Objectives
I	Introduction to crystallography – Crystal systems – Symmetry elements – Isometric, Tetragonal, Orthorhombic, Hexagonal, Monoclinic and Triclinic systems – Normal classes.	12	CO1
II	Stereographic projections – Axial ratio – Zones and	12	CO2

	zonal symbols – Tautozonal faces – Equation of the normal – Napier's Theorem – Tangent relations – Sine ratio – Cosine ratio.		
III	Description and composition of the following mineral groups: Quartz, Feldspars, Feldspathoids, Micas, Garnets, Olivine, Pyroxenes, Amphiboles, Zeolites and Carbonate minerals.	12	CO3
IV	Introduction to Optical Mineralogy Electrical, magnetic and optical properties of minerals – Properties of light – Transmissivity and Reflectivity – Polarization – Extinction – Dichroism – Pleochroism – Interference colors – Refringence and Birefringence – Order of interference – Conoscopy – Interference figures - Concepts of crystal field theory and mineralogical spectroscopy.	12	CO4
V	Spot tests – Paper chromatography – Nephelometry – Turbidimetry – Spectroscopy – Flame photometry – X-ray spectroscopy – UV spectroscopy – Mass spectroscopy – Accelerated mass spectroscopy.	12	CO5
	Total	**60**	
1.	Donald Bloss F. (1971) Crystallography and Crystal Chemistry – An Introduction published by Holt, Rinehart and Winston, Inc., New York.		
2.	William M. Blackburn and William H. Dennen (1988) Principles of Mineralogy (Second Edition) published by WCB Publishers England.		
3.	Kerr P.F, Optical Mineralogy, 4th ed McGraw Hill New York (1977)		
4.	Gribble C.D. &A.J. Hall, A. Practical Introduction to Optical Mineralogy,Springer.London(1985)		
5.	Tisljar, S.K. Haldar, Josip (2013). Introduction to mineralogy and petrology. Burlington: Elsevier Science. ISBN 9780124167100.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Cornelis Klein and Cornelius S. Hurlbut, Jr. (1993) Manual of Mineralogy published by John Wiley & Sons, Inc. Singapore.		
2.	Paul F. Kerr (1967) Optical Mineralogy, John Wiley & Sons, New York.		
3.	Wenk, Hans-Rudolf; Bulakh, Andrey (2016). Minerals: Their Constitution and Origin. Cambridge University Press. ISBN 9781316425282.		
4.	Whewell, William (2010). "Book XV. History of Mineralogy". History of the Inductive Sciences: From the Earliest to the Present Times. Cambridge University Press. pp. 187–252. ISBN 9781108019262.		
5.	Laudan, Rachel (1993). From mineralogy to geology : the foundations of a science, 1650-1830 (Pbk. ed.). Chicago: University of Chicago Press. ISBN 9780226469478.		
Web Resources			
1.	https://mineralogy-ima.org/		
2.	https://www.socminpet.it/dwl.php?file=SIMP/GNM/SIMP_ELEM.pdf		

3.	https://www.mineralogicalassociation.ca/
4.	https://www.cambridge.org/core/societies/mineralogical-society-of-great-britain-and-ireland
5.	http://www.minsocam.org/

Course outcome

CO1: Basic knowledge on crystal structures and bonding and laws
CO2: Student can learn about the Silicate structures and their physical and chemical properties
CO3: Students get knowledge about the description and composition the minerals
CO4: Student gain knowledge on Optical mineralogical studies
CO5: Student apply the instrumentation techniques in mineralogical studies.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	2	2	3	1	2	3	2	1	2
CO 2	3	2	2	3	1	2	3	2	1	2
CO 3	3	2	2	3	1	2	3	2	1	2
CO 4	3	2	2	3	1	2	3	2	1	2
CO 5	3	2	2	3	1	2	3	2	1	2

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- I: (First year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOP103	**Core III : Mineralogy and Paleontology Practical**	Core	-	-	10	-	4	-	25	75	100
Course Objectives											
CO1	To identify minerals in hand specimens.										
CO2	To learn the optical properties of minerals through microscopes.										
CO3	To determine the three dimensional & visualization of crystals.										
CO4	To identify pre historic species.										
CO5	Able to understand the evolution of organism in different periods.										
Mineralogy:	i. Megascopic identification of: Quartz, Feldspar – Orthoclase & Plagioclase, Pyroxene, Amphibole, Mica, Tourmaline, Topaz, Beryl, Zircon, Rutile, Apatite, Calcite, Gypsum. Metamorphic minerals: Garnet, Cordierite, Kyanite, Sillimanite, Andalusite, Sphene, Staurolite, Chondrodite. ii. Microscopic study of: Quartz, Feldspar – Orthoclase & Plagioclase, Pyroxene, Amphibole and other accessory minerals. iii. Optical experiments: a) Determination of plagioclase orientation in thin section and its Anorthite content from extinction angle measurements. b) Birefringence of minerals-using Berek compensator. c) Pleochroic scheme d) 2V by Mallards method, e) Optic signs of uniaxial and biaxial minerals. iv. Calculation of molecular and structural formulae of some important minerals. **v.** Stereographic projections of crystals of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic system. Calculation of axial ratios, miller indices of faces application of Weiss zone law, Tangent relationships, Napier's rule, law of anharmonic ratio and equation to normal.										

Paleontology:	i. **Mollusca: Pelecypoda** - Arca, Glycimeris (Pectenculus) Inoceramus, Ostrea, Alectryonia, Pecten, Spondylus, Trigonia, Pholadomya, Cardita, Hippurites, Cardium, Venus, Unio, Megalodon, Meretrix, Gryphaea, Exogyra. ii. **Gastropoda:-** Natica, Trochus, Turbo, Turritella, Fusus, Conus, Murex, Physa, Busycon iii. **Cephalopoda:** Natilus, Goniatites, Ceratities, Ammonite, Phyiloceras, Acanthoceras, Scaphites, Turrilites, Belemininites iv. **Brachiopoda:** Lingula, Orthis, Productus, Pentamerus, Rhynoconella, Terebratula, Atrypa, Spirifer and Athyris. v. **Echinoidea:** Cidaris, Hemicidaris, Stigmatophygus, Holaster, Hemiaster, Micraster. vi. **Echinodermata :Crinoids;** Encrinus, Marsupites vii. **Blastoidea:** Pentremites viii. **Arthropoda: Trilobita**; Paradoxides, Olinus, Ollenellus, Calymene, Phacops ix. **Hemichordate: Graptoloidea;** Tetragraptus, didymograptus, Phyllograptus, Diplograptus, Monograptus, Rastites x. **Plant fossils:** Calamites, Sphenophyllym, lepidodendron, Sigillaria, Glossopteris, Gangamopteris, Gondwanadium, Ptilophyllum.
Reading List (Print and Online)	1. Donald Bloss F. (1971) Crystallography and Crystal Chemistry – An Introduction published by Holt, Rinehart and Winston, Inc., New York. 2 William M. Blackburn and William H. Dennen (1988) Principles of Mineralogy (Second Edition) published by WCB Publishers England.
Recommended Texts	1. Cornelis Klein and Cornelius S. Hurlbut, Jr. (1993) Manual of Mineralogy published by John Wiley & Sons, Inc. Singapore. 2. Paul F. Kerr (1967) Optical Mineralogy, John Wiley & Sons, New York.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	3	1	3	3	1	3	2	3	2
CO 2	2	3	1	3	3	1	3	2	3	2
CO 3	2	3	1	3	3	1	3	2	3	2
CO 4	3	3	3	3	3	3	2	3	3	3
CO 5	3	3	3	3	3	3	2	3	3	3

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE104	**Elective paper I** **Recent Trends in Paleontology**	Elective	Y	-	-	-	3	5	25	75	100

Course Objectives	
CO1	Learn about the origin and evolution of life, understanding species concept and study of the major events in the history of Precambrian and Phanerozoic life. Detailed study about vertebrate paleontology.
CO2	Learn about the morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms.
CO3	To explain about geological history, geographical distribution and description of more important genera
CO4	Demonstrating the sampling methods and sample processing techniques of micropaleontology.
CO5	To know about the application of micropaleontology in hydrocarbon exploration.

UNIT	Details	No. of Hours	Course Objectives
I	Fossil record and geological time-scale. Evolutionary changes in molluscs and mammals in geological time. Principles of evolution.Use of species and genera of foraminifera and Echinodermata in biostratigraphic correlation. Different microfossil groups and their distribution in India. Functional morphology, evolution and significance of Plant Fossils, Fishes, Horse, Elephant and Man. Dinosaurs and their extinction. Taphonomy and environmental factors, Oxygen and Carbon isotope studies of fossils and paleoclimates – Palaeobiogeographic Provinces.	12	CO1
II	Theories on origin and evolution of life – Phylogenetic and Ontogenic Analysis – Species Concept – Types of Fossils and Types of Species – Palingensis – Coenogensis – Proterogenesis - Thanatocoenosis – Biocoenosis – Sidocoenosis - Biomineralisation and Trace Fossils – Fossils and their uses – Biometrics – Major events in the history of Precambrian and Phanerozoic life.	12	CO2
III	Vertebrate paleontology: Succession of vertebrate life through geologic time. Broad classificationand study of some characteristic Indian vertebrate genera. Indian pre-Tertiary vertebrate - their distribution and	12	CO2

	paleogeographic implication; extinction of dinosaurs. Indian Tertiary vertebrate - Siwalik mammals; phylogeny - Equidae and Proboscidae. Indian fossil Hominoides and modern theories regarding human evolution.		
IV	Invertebrate paleontology: an overview. Morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms - Porifera, Bryozoa, Mollusca, Brachiopoda. Geological history, geographical distribution and description of more important genera of Trilobita, Echinoides, Coelenterata and Graptoloidea.	12	CO2
V	Micropaleontology: Sampling methods and sample processing techniques. Types of microfossils.Calcareous Microfossils - Foraminifera - major morphologic groups; Benthic Foraminifera; depth biotopes, value in paleobathymetric determination. Larger foraminifera – their utility in Indian stratigraphy. Planktonic foraminifera and calcareous nannofossils. Ostracoda - outline morphology, paleoecology & geological history. Brief knowledge about pteropods, calpionellids and calcareous algae. Application of micropaleontology in hydrocarbon exploration.	12	CO2
	Text Books		
1.	Palaeontology Evolution and animal distribution. .C. Jain and M.S. Anantharaman, (1996), Vishal Publications, Jalandhar.		
2.	Invertebrate Palaeontology - H.Woods, (1985), CBS Publishers and Distributors, New Delhi.		
3.	Agashe, S.N, Paleo botany, Oxford & IBH. Delhi(1995)		
4.	Stewart W.N. & G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005)		
5.	Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952).		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Principles of Invertebrate Palaeontology, Shrock R.R and Twenohofel W.H, (2005), CBS Publishers and Distributors, New Delhi.		
2.	Invertebrate Fossils. Moore R.C, Lalicker C.G and Fisher A.G (1952) McGraw Hill.		
3.	The Vertebrate Story, Romer A.S, (1959) University of Chicago Press, 4thEdt. Chicago.		
4.	Palaeontology An Introduction, E.W.Nield and V.C.T.Tucker (1985) Pergamon Press, Oxford.		
5.	Colbert E.H. et al.,Evolution of the Vertebrates, Wiley. New Delhi 2002)		
Web Resources			
1.	https://en.wikipedia.org/wiki/Age_of_Earth		

2.	https://www.lyellcollection.org/doi/10.1144/GSL.SP.2001.190.01.14.
3.	https://digitalatlas.cose.isu.edu/geo/basics/fossil.htm
4.	https://www.sciencedirect.com/topics/immunology-and-microbiology/hemichordata
5.	https://www.qm.qld.gov.au/Explore/Research/Biodiversity

Course outcome:

CO1: Student can understand about the fossil record and geological time-scale
CO2: To get knowledge about the theory and Origin of life
CO3: Stundents get more knowledge about vertebrate paleontology
CO4: Stundents get more knowledge about Invertebrate paleontology
CO5: Student gain knowledge on micropaleontology: Sampling methods and sample processing techniques

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	3	1	3	3	1	3	2	3	2
CO 2	2	3	1	3	3	1	3	2	3	2
CO 3	2	3	1	3	3	1	3	2	3	2
CO 4	3	3	3	3	3	3	2	3	3	3
CO 5	3	3	3	3	3	3	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE105	**Elective paper II Stratigraphy of India and its Applications**	Elective	Y	-	-	-	3	5	25	75	100
Course Objectives											
CO1	Can recall the Stratigraphy of India.										
CO2	Can differentiate different deposits of geological time.										
CO3	To understand and compare different applications related to Stratigraphy.										
CO4	Can interpret the sequence of stratigraphic column.										
CO5	Can identify different processes involved during different geological time.										

UNIT	Details	No. of Hours	Course Objectives
I	**Stratigraphy of India –** Dharwar Supergroup – Mineral riches of Archaean. Cuddapah system and its mineral riches. Vidhyan system and its mineral riches. Cambrian System – Salt Range and Age of Saline Series. Ordovician and Silurian systems.	12	CO1
II	**Stratigraphy of India (Contd.) -** Devonian system. Carboniferous system. The Gondwana Group – Structure of the Gondwana Basin – Climate and Sedimentation – Economic minerals in the Gondwanas. Upper Carboniferous and Permian systems – Triassic system – Lilang system - Jurassic system – Jurassic of Kutch - Cretaceous system – Cretaceous of Trichinopoly.	12	CO2
III	**Stratigraphy of India (Contd**.) - Deccan traps – Lameta beds – Infra-trappean and Inter-trappean beds – Age of Deccan traps – Economic riches of Deccan traps. Tertiary group – Rise of the Himalayas – Eocene system and its Economic minerals – Oligocene and Lower Miocene systems and Petroleum – Middle Miocene and Lower Pleistocene – Siwalik system – Pleistocene and Recent – Culture, Climate and deposits in India – Human evolution and Culture – Glaciation and Human Culture – Chronology of Glaciation – Karewa formation – Potwar silts and Loess – Indo-Gangetic alluvium – Coastal deposits – Aeolian and other deposits – Recent deposits – Useful Mineral deposits of Pleistocene and Recent – Soils – Recent changes of level along the coast – Changes in the courses of rivers.	12	CO2
IV	**Applications of Stratigraphy –** Geological time - Geologic time Units – Geochronology. Chronostratigraphy - Golden spikes – Global Standard Section and Point (GSSP) – Stratigraphic Units.	12	CO2

	Lithostratigraphy - Stratigraphic relationships - Lithostratigraphic Units – Lithodemic units – Application of Lithostratigraphy – Gaps in the record. Biostratigraphy – Fossils and Stratigraphy – Classification of organisms – Evolutionary trends – Biozones and Zone fossils – Taxa used in Biostratigraphy – Biostratigraphic correlation – Biostratigraphy in relation to other stratigraphic techniques.		
V	**Applications of Stratigraphy** (Contd.) - dating and correlation techniques – Radiometric dating – Application of radiometric dating – Other isotopic and chemical techniques – Chemostratigraphy – Magnetostratigraphy – Dating in the quaternary. Sequence stratigrphy - Sea-level changes – Sea level changes and sedimentation – Depositional sequences and systems tracts – Parasequences and its components of system tracts – Carbonate sequence stratigraphy – Sequence stratigraphy in non-marine basins – Alternative schemes in sequence stratigraphy – Applications of sequence stratigraphy – Causes of sea level fluctuations.	12	CO2
	Text Books		
1.	Geology of India and Burma M.S. Krishnan, (2010), 6th Edi., C.B.S publishers and Distributors, Delhi		
2.	Geology of India, D.N. Wadia, (1966), McMillan company, London		
3.	Vaidyanadhan.R&M.Ramakrishnan, Geology of India. Geological Society of India. Bangalore(2008)		
4.	Mehdiratta R.C,Geology of India, Pakisthan, Bangladesh and Burma. Atma Ram &Sons.Delhi(1974)		
5.	Geology& Mineral Resources of the States of India. Misc Pub.No.30.Geological Survey of India. Kolkota. (Several individual volumes available online at GSI portal) GSI(2005).		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Fundamentals of Historical Geology and Stratigraphy of India, Ravindrakumar (1985), Wiley Eastern ltd, New Delhi.		
2.	Principle of Stratigraphy, Dunbar and Roggers, (1964), John Wiley and co, New York		
3.	An Introduction in Stratigraphy, Stamp L.D, (1964), Thomas Murby, Museum St, WCI, London.		
4.	Stratigraphic Principles and Practices, Weller, J.M, (1962), Harper & Bros, New York		
5.	Kumar R,Fundamentals of Historical Geology and Stratigraphy of India,WiIey.New Delhi (1988).		
Web Resources			
1.	https://stratigraphy.org/		
2.	https://www.sepm.org/		

3.	https://www.geosocindia.org/
4.	https://www.moes.gov.in/
5.	https://isegindia.org/

Course outcomes:

CO1: Students studied and gain knowledge on Dharwar Supergroup – Mineral riches of Archaean.
CO2: Students able to understand about the Gondwana Group and its stratigraphy.
CO3: Students get knowledge on Deccan traps.
CO4: Students understand the Stratigraphy of India.
CO5: Students used to study the Applications of Stratigraphy.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	2	3	1	3	3	1	3	2	3	2
CO 2	2	3	1	3	3	1	3	2	3	2
CO 3	2	3	1	3	3	1	3	2	3	2
CO 4	3	3	3	3	3	3	2	3	3	3
CO 5	3	3	3	3	3	3	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- II: (First year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC201	**Core IV Structural Geology and Geotectonics**	Core	Y	-	-	-	5	5	25	75	100
Course Objectives											
CO1	The student can interpret and evaluate different structures that exist in the earth.										
CO2	Can critically assess and review the energy needed to cause different structures.										
CO3	Can describe and explain major and minor structures.										
CO4	Can understand to compare and contrast structures related to each other.										
CO5	Can evaluate and explain the causes of different structures.										

UNIT	Details	No. of Hours	Course Objectives
I	Theory of stress and strain – Behavior of rocks under stress – Mohr's circle – Various states of stress and their representation by Mohr's circles – Different types of failure and sliding criteria – Geometry and mechanics of fracturing and conditions for re-activation of pre-existing discontinuities – Paleostress analysis – Common types of finite strain – Ellipsoids – L-, L-S-, and S-tectonic fabrics.	12	CO1
II	Techniques of strain analysis – Particle paths and flow patterns – Progressive strain history and methods for its determination. Deformation mechanisms – Role of fluids in deformation processes – Geometry and analysis of brittle-ductile and ductile shear zones – Petrofabric analysis – Field and laboratory techniques – Point and percentage diagrams – Preparation of petrofabric diagrams of quartz, biotite and calcite – Symmetry of fabric – Symmetry of movement.	12	CO2
III	Rotated minerals – Syn-, pre- and post-kinematic – Differential movement in rocks using rotated minerals – Oscillatory movements – Characteristics – Neotectonics – Indian and global evidences – Methods of study of neotectonics. Sheath folds – Geometry and mechanics of development of folds – Boudins – Foliation and lineation – Interference patterns and structural analysis in areas of superposed folding – Fault-related folding – Geometry and mechanics of faults – Gravity-induced structures.	12	CO2

IV	Major tectonic features and associated structures in extensional-, compressional-, and strike-slip terrains – Joints and unconformities – Penecontemporaneous deformational structures of sedimentary rocks. Plate tectonics – Concept and principles – Continental drift – Geological and geophysical evidences – Mechanics, objections and present status of plate tectonics.	12	CO2
V	Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains – Geological and geophysical characteristics of plate boundaries – Geodynamic evolution of the Himalayas – Paleomagnetism – Sea floor spreading and plate tectonics – Island arcs, oceanic islands and volcanic arcs – Isostasy, orogeny and epeirogeny – Geodynamic of the Indian Plate.	12	CO2
	Text Books (Latest Editions)		
1.	Billings, M.P. (2014) *Structural Geology*. Prentice-Hall, Inc., Learning Pvt. Ltd., Delhi. 3rd Edition. ISBN: 978-81-203-0059-03.		
2.	Beloussov, V.V. (1962).*Basic Problems in Geotectonics*. McGraw-Hill Book Co., New York.		
3	Badgeley, P.C. (1965) *Structural and Tectonic Principles*. Harper & Row Publishers, New York. ASIN: BOOBXTMTK6.		
4	Twiss, R.J. and Moores, E.M. (2007).*Structural Geology*. W.H.Freeman and Company, New York. 2nd Edition. ISBN: 10: 0-7167-4951-		
5	B.A. van der Pluijm and S. Marshak (2004). Earth Structure - An Introduction to Structural Geology and Tectonics (2nd ed.). New York: W. W. Norton. p. 656. ISBN 0-393-92467-X.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Suppe, J. (1985) *Principles of Structural Geology*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: ISBN 0137105002.		
2.	Marshak, S. and Mitra, G. (1988) *Basic Methods of Structural Geology*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: 0130651788.		
3.	M. King Hubbert (1972). Structural Geology. Hafner Publishing Company.		
4.	G.H. Davis and S.J. Reynolds (1996). The structural geology of rocks and regions (2nd ed.). Wiley. ISBN 0-471-52621-5.		
5.	C.W. Passchier and R.A.J. Trouw (1998). Microtectonics. Berlin: Springer. ISBN 3-540-58713-6.		
Web Resources			
1.	http://www.labotka.net		
2.	http://www.patnasciencecollege.org		
3.	https://geomorphology.org.uk		
4.	https://gradeup.co		
5.	https://www.nps.gov>subjects>gla		

Course outcome:

CO1: To gain knowledge about the geological structures like fold, fault, unconformity, foliation and lineation and its causes and mechanisms.
CO2: Gain knowledge on techniques of strain analysis
CO3: Student learn about the Methods of study of neotectonics
CO4: Student understand on Major tectonic features and associated structures in extensional-, compressional-, and strike-slip terrains – Joints and unconformities

CO5: Student gain knowledge on Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	2	3	3	2
CO 2	3	3	3	2	3	3	2	3	3	2
CO 3	3	3	3	2	3	3	2	3	3	2
CO 4	3	3	3	2	3	3	3	3	3	2
CO 5	3	3	3	2	3	3	3	3	3	2

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC202	**Core V Applied Remote Sensing and GIS**	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
CO1	Understand the basics of remote sensing, electromagnetic radiation (EMR) and its properties, aerial photography and to list the important merits of these technology tools.
CO2	Students will comprehend the core part of remote sensing i.e. spectral properties of earth objects, interaction of EMR with the atmosphere and the acquisition of data by different satellite sensors including the generate of False Color Composite (FCC) imagery.
CO3	Based on the understanding of the basics, the students are expected to do thorough interpretation of aerial photographs and FCC imagery for the preparation of various thematic maps.
CO4	Acquiring advanced skills on the aspects of digital image processing and the Spatial Information Technology tools, the students are expected to do quantitative analysis on change detection, monitoring of resources etc.
CO5	Evaluate the importance of these technology tools over conventional techniques and its way forward.

UNIT	Details	No. of Hours	Course Objectives
I	Fundamentals of remote sensing: History of remote sensing technology – Remote sensing system – Electromagnetic radiation – Spectral properties of terrestrial objects – Analysis of spectral reflectance curves – Types of satellites – Image acquisition – Multi-spectral scanners – Remote sensing resolution – Introduction to thermal remote sensing – Introduction to microwave remote sensing and new satellite sensors – Remote sensing in landform and land use mapping, structural mapping, coastal and ocean studies – Global and Indian space missions.	12	CO1
II	Aerial photography: Introduction – Vertical and oblique photographs – Photoscale – Image displacement due to relief – Parallax in aerial photographs – Aerial photographic procedures – Camera and flight requirement – Flight planning – Filters – Compensation – Stereoscopy – Photomosaics. Photographical studies –	12	CO2

	Photo recognition elements and keys – Interpretation of lithology, structures and landforms from aerial photographs.		
III	Image processing in remote sensing: Digital data recording – Digital data format. Introduction to digital image processing – Pre-processing techniques – Image classification methods – Image enhancement techniques.	12	CO2
IV	Applications of remote sensing: Visual interpretation – Different sensors – Data and image interpretation key elements. Exercises on mapping of geology – Land use/land cover and geomorphology based on visual method – Preparation of base maps and transformation of thematic maps. Validation of remote sensing analysis output by ground truth – Accuracy, estimation and introduction to GPS technology.	12	CO2
V	Fundamentals and application of GIS: Concept of GIS – GIS types – Data storage – Retrieval and analysis. GIS database organization and development – Combined use of remote sensing and GIS. Preparation of spatial decision support system (SDSS).Highlights on different applications using GIS tool with particular reference to Applied Geosciences and Ocean Science.	12	CO2
	Text Books		
1.	Asrar, G. (1989) *Theory and Applications of Optical Remote Sensing*. John Wiley & Sons, New York.		
2.	Curran, P.J. (1984) *Principles of Remote Sensing*. Longman Group Ltd.		
3	Lillesand, T.M., Kiefer, R.W. and Chipman, J.W. (2007) *Remote Sensing and Image Interpretation.* Wiley India, 763.		
4	Paul R. Wolf. (1986) *Elements of Photogrammetry*, McGraw-Hill Book company. 628.		
5.	Lasaponara, R. and Masini N. 2012: Satellite Remote Sensing - A new tool for Archaeology. Remote Sensing and Digital Image Processing Series, Volume 16, 364 pp., ISBN 978-90-481-8801-7.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Sabins, F.F. (1998) *Remote Sensing Principles and Interpretation*. W.H.Freeman& Co		
2.	Agarwal, C.S. and P.K. Garg (2000) *Textbook on Remote Sensing In natural resources monitopring and management,* Wheeler Publishing, 196.		
3.	Campbell, J. B. (2002). Introduction to remote sensing (3rd ed.). The Guilford Press. ISBN 978-1-57230-640-0.		

4.	Jensen, J. R. (2007). Remote sensing of the environment: an Earth resource perspective (2nd ed.). Prentice Hall. ISBN 978-0-13-188950-7.
5.	Richards, J. A.; X. Jia (2006). Remote sensing digital image analysis: an introduction (4th ed.). Springer. ISBN 978-3-540-25128-6.
Web Resources	
1.	https://stratigraphy.org/
2.	https://www.sepm.org/
3.	https://www.geosocindia.org/
4.	https://www.moes.gov.in/
5.	https://isegindia.org/

Course outcome:

CO1: To gain the basic concept of remote sensing
CO2: Students study the Photogeology
CO3: Student get knowledge on Image processing in remote sensing
CO4: Students learn about the Applications of remote sensing
CO5: Students gain knowledge on Fundamentals and application of GIS

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	S	3	3	2	3	3	3	2	3	3
CO 2	S	3	3	3	3	3	3	3	3	3
CO 3	S	3	3	3	3	3	2	2	3	2
CO 4	S	3	3	3	2	3	3	3	3	3
CO 5	S	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester- II: Structural Geology & Geotectonics Practical and Petrology practical (Ist year)

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
23GEOP203	**Core VI Structural Geology & Geotectonics Practical and petrology practical**	Core	Y	-	-	-	4	8	25	75	100

Course Objectives			
CO1	To identify and list out the issues and problems.		
CO2	To describe and explain the solution to follow		
CO3	To identify various properties of rocks.		
CO4	To Understand petrogenetic aspects of important rock suites of India.		
CO5	To different between different structures. To conceive and conceptualize the solutions arrived at.		
	STRUCTURAL GEOLOGY		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
Structural Geology	Determination of attitude of beds – Geometrical, graphical and trigonometric projections – Tabular and nomograph methods.	12	CO1
	Reconstruction of parallel fold and fault – Preparation and analysis of structure contour map – Isopachs.	12	CO2
	Construction of perpendicular and vertical sections of plunging fold. Geochronology – Pi and beta diagrams – Structural complex –	12	CO2
	Depth to strata – True thickness of beds - Interpretation of geological maps involving normally dipping beds, bore well data.	12	CO2
	Interpretation of geological maps involving symmetrical and asymmetrical fold, isoclinal fold, recumbent fold, plunging fold, strike fault and step fault.	12	CO2

	PETROLOGY PRACTICAL		
Petrology	Megascopic and microscopic study (textural and mineralogical) of the following igneous rocks: Granite, Syenite, Gabbro, Basalt, Peridotite, Pyroxenite, Dunite. Lamprophyres, Dolerite, Phonolite, Rhyolite, Trachyte, Andesite, Pitchstone, Anorthosite, Aplite, Pegmatite. Introduction to modal analyses of Granite, Basalt and Gabbro.	12	CO1
	Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks: Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite-quartz schist, slate, talc-tremolite-calcite-quartz schist. Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble. Laboratory exercises in graphic plots for petrochemistry and interpretation of paragenetic diagrams.	12	CO1
	Megascopic and microscopic study (textural and mineralogical) of the following Sedimentary rocks: Sand stone, Lime stone, Conglomerate, Arkose, mud rocks.	12	CO2
	Preparation of Thin sections – Grain size analysis – Statistical parameters in Sedimentology – Frequency and cumulative frequency distribution curves – Moment and graphic measures – Gravel analysis.	12	CO3
	Text books		
1.	Brian Simpson. (1968).*Geological Maps*. Pergamon Press Limited, Oxford.		
2.	Lisle, R.J. (1988).*Geological Structures and Maps*. Pergamon Press, Oxford.		
3	Gass, J.G., Butcher, N.E., Clark, P., Francis, P.W., Jackson, D.E., McCurry, P., Skipsey, E., Smith, P.J., Stevenson, J., Thorpe, R.S., Turner, C., Wilson, R.C.L., Wright, J.B. (1972). *Field Relations – A Second Level Course in Science*. The Open University Press, London.		
4.	Structural geology, Billing. M.P. (1974), Prentice Hall, New Delhi		
5.	An outline of Structural Geology, Hobbs, B.E., Means, W.D. and Williams, P.F. (1976):, John Wiley, New York.		
6.	Vernon R. H. and Clarke G. L. 2008. Principles of metamorphic Petrology. Cambridge publication.		
7.	John D. Winter 2001. An Introduction to Igneous and Metamorphic Petrology.		
8.	Wenk,H.R&A. Bulakh, Minerals, Cambridge University Press,New Delhi(2006)		
9.	Perkins D, 3rd ed. Prentice Hall India, NewDelhi(2010)		
10.	HaIdar,S.K.&J.Tisjlar, Introduction to Mineralogy and Petrology, Elsevier,(2014)		

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Bhattacharya, D.S. and Bagchi, T.C. (1973).*Elements of Geological Map Reading and Interpretation with Exercises*. Orient Longman Limited, Calcutta.
2.	Gokhale, N.W. (2006).*A Manual of Problems in Structural Geology*. CBS Publishers and Distributors, New Delhi.
3.	Basic Problems of Geotectonics Belousov.V.V. (1962):, McGraw Hill, New York
4.	Structural Geology De Sitter. L.U. (1956):, McGraw Hill, New York
5.	Elements of Structural Geology Hill. E.S. (1972):, John Wiley, New York
Web Resources	
1.	https://stratigraphy.org/
2.	https://www.sepm.org/
3.	https://www.geosocindia.org/
4.	https://www.moes.gov.in/
5.	https://isegindia.org/

Course outcome:

CO1: Students workout on the determination of attitude of beds.
CO2: Student gain knowledge on preparation and analysis of structure contour maps.
CO3: Students learn about the Construction of perpendicular and vertical sections of plunging fold.
CO4: Study the Megascopic and microscopic study for igneous rocks.
CO5: Preparation of Thin sections.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	2	3	1	3	2	3	1	1
CO 2	3	3	2	3	1	3	2	3	1	1
CO 3	3	3	2	3	1	3	2	3	1	1
CO 4	3	3	2	3	1	3	2	3	1	1
CO 5	3	3	2	3	1	3	2	3	1	1

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE204	**Elective – III Applied Petrology**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	Understanding the basics of the Earth as a System.
CO2	To analyze various magmatic compositions to understand the formation of various igneous rocks.
CO3	To comprehend the genesis of metamorphic rocks.
CO4	To understand the formation of sedimentary rocks, their depositional environments and provenance
CO5	Understanding the complete system of the Earth

UNIT	Details	No. of Hours	Course Objectives
I	Forms, textures and structures of igneous rocks. Petrology and geotectonic evolution of granites, basalts, andesites and alkaline rocks. Petrology of gabbros, kimberlites, anorthosites and carbonatites.Origin of primary basic magmas. Classification of igneous rocks. Steady-state geotherms. Genesis, properties,	12	CO1

	emplacement and crystallization of magmas. Phase equilibrium studies of simple systems, effect of volatiles on melt equilibria. Magma -mixing, - mingling and - immiscibility. Generation of magmas. Factors affecting their evolution and their relation to plate tectonics– Magmatic differentiation and Assimilation. Variation diagrams.		
II	Silicate melts equilibria, binary and ternary phase diagrams. Experimental Petrology - Phase equilibrium of binary and ternary silicate systems and its petrological implications – Effect of Pressure on silicate systems – Trace elements in magmatic crystallization – Trace element modelling. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, alkaline rocks, Kimberlites, ophiolites and granitoids.	12	CO2
III	Basic Concepts of Metamorphic Petrology – Types of metamorphism – agents of metamorphism – Zones and grades. Facies concept of metamorphism. Graphical Representation of metamorphic paragenesis Petrogenesis of important metamorphic rocks – charnockite – eclogite – amphibolite – migmatites – Khondalites – metamorphic belts Textures and structures of metamorphic rocks. Regional and contact metamorphism of pelitic and impure calcareous rocks.Mineral assemblages and P/T conditions. Experimental and thermodynamic appraisal of metamorphic reactions. Characteristics of different grades and facies of metamorphism. Metasomatism and granitization, migmatites.Plate tectonics and metamorphic zones. Paired metamorphic belts. Mineral reactions with condensed phases, solid solutions, mixed volatile equilibria and thermobarometry.	12	CO2
IV	Earth Surface System: Liberation and flux of sediments, Processes of transport and generation of sedimentary structures, Control on the sedimentary record, Cyclic Sediments, – Classification of sedimentary rocks – Definition, measurements and interpretation of grain size. Evolution of Sedimentary Basins: Classification and definition of Sedimentary basins, Tectonics and Sedimentation – Plate tectonic concepts – Sedimentary basins of India – Paleocurrent and Basin analysis – Provenance and Diagenesis of sediments.	12	CO2
V	Sedimentary environments and facies, Continental alluvial – fluvial, lacustrine, desert – Eolian and Glacial	12	CO2

	sedimentary systems; Shallow Coastal Facies, Marine and Continental Evaporates; Shallow water Carbonates; Deep sea basins; Volcanoclasts Petrography of rocks of Clastic, Chemical and Biochemical origin, Clastic Petrofacies, Paleoclimate and Paleoenvironment analyses; Application of trace elements, Rare-earth elements and Stable isotope geochemistry to sedimentological problems. Depositional environments and systems. Paleocurrent analysis.		
	Text Books		
1.	Philpotts, A., 1992, Igneous and Metamorphic Petrology, Prentice Hall.		
2.	Turner,F.J., 1980, Metamorphic Petrology, McGraw Hill., New York.		
3.	Best M.G,Igneous Petrology.Wiley.NewDelhi(2005)		
4.	Hatch,F.H. et al,Petrology of the Igneous Rooks, CBSDelhi.		
5.	Hyndman D.W, Petrology of the Igneous and Metamorphic Rocks McGrawHill.NewYork(1985)		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Bose, M.K., 1997, Igneous Petrology., World Press.		
2.	Bucher, K and Frey, M., 1994, Petrogenesis of Metamorphic Rocks, Springer – Verlag.		
3.	Winter,J.D,Principles of Igneous and Metamorphic Petrology, PHI.New		
4.	Middlemost E.A.K,Magmas and Magmatic Rocks.Longman UK(1985)		
5.	Winkler,H.G.F, Petrology of the Metamorphic Rocks. Springer,New Delhi(1970)		
Web Resources			
1.	https://minerva.union.edu/hollochk/c-petrology/resources.html		
2.	https://topex.ucsd.edu/es10/lecture/lecture10/lecture10.html		
3.	https://geology.com/rocks/igneous-rocks.shtml		
4.	https://course.lumenlearning.com/wmopen-geology/chapter/outcome-metamorphic-rocks/		
5.	https://serc.carleton.edu/NAGTWorkshops/coursedesign/goalsdb/10875.html		

Course outcome:

CO1:To gain knowledge about the study of rocks - igneous, metamorphic, and sedimentary - and the processes that form and transform them.
CO2: Students gain on Silicate melt equilibria, binary and ternary phase diagrams.
CO3: students learn about the Basic Concepts of Metamorphic Petrology
CO4: Students learn Definition, measurements and interpretation of grain size
CO5: Students get knowledge on Sedimentary environments and facies.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	3	3	3	3	3	3
CO 2	3	2	3	3	3	3	2	3	1	3
CO 3	3	3	3	3	3	3	2	3	3	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	1	1	2	3	3	3	2	1	2	2

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE205	**Elective paper IV Environmental Earth Science**	Elective	Y	-	-	-	3	4	25	75	100
Course Objectives											
CO 1	To identify knowledge on various types of environmental issues in relation to the Earth as a System										

CO 2	To explain the various causes of pollution		
CO 3	To explain the various types of pollution		
CO 4	To select the remedial measures to be taken as an individual and a group		
CO 5	Understanding the dynamics of the Earth		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Concept of environment – Environmental monitoring – Water as a resource, Water pollution – Point and non-point pollution sources – Ground water pollution.	12	CO1
II	Air pollution – Natural and anthropogenic sources of air pollution – Primary and secondary air pollutants – Anthropogenic activities and air pollution – Indoor air quality – Biological sources of indoor pollution – Health effects – Air quality standards – Case histories – Air quality monitoring – Acid rain – Adverse effects of acid rain – Health effects – Mitigation measures – Roles and responsibilities.	12	CO2
III	Smog – Mechanism of smog formation – Health disorders – Photochemical smog – Ozone and PAN formation – Health effects – Catalytic converters – Greenhouse gases and effect – Processes of removal of greenhouse gases.	12	CO2
IV	Methods of waste disposal – Landfills – Trash compactors – Incineration – Recycling – Biological processing – Mulch and compost – Energy production – Waste reduction – Waste handling and transport – Waste management – Concept of waste hierarchy – Education and awareness.	12	CO2
V	Medical geology – Problems associated with fluoride, arsenic, asbestos, mercury, chromium, cadmium, zinc, copper and lead contamination – Alternate energy resources – Climate change.	12	CO2
	Text Books		
1.	Fair bridge, R.W. (1972) *Encyclopedia of Geochemistry and Environmental Science*. John Wiley.		
2.	Keller, Edward A. (1996) *Environmental Geology*. New Jersey: Prentice-Hall		
3.	Coppola D.P, Introduction to International Disaster Management, Butterworth Heinemann(2007)		
4.	Pine,J.C, Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group(2009)		
5.	Smith K, Environmental Hazards: Assessing Risk and Reducing Disaster Rout ledge Press(2001)		

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Strahler, A.N. and Strahler, A.H. (1973) *Environmental Geoscience – Interaction between Natural Systems and Man*. Hamilton Publishing Co., Santa Barbara, California.
2.	Kudesia, V.P. (1980) *Water Pollution*. Pragathi Prakasam, Meerut.
3.	Groundwater Assessment Development and Management, Karanth.K.R. (1987) Tata McGraw Hill Publishing Company, Ltd.
4.	Miller T.G. Environmental Science. Wadsworth Publishing.US(2004).
5.	Coates,D.R. Environmental Geology. McGraw Hill.NewYork(1984)
Web Resources	
1.	https://www.britannica.com/science/geology/sedimentary-petrology
2.	https://limk.springer.com/chapter/10
3.	https://www.geo.mtu.edu/UPSeis/hazards.html
4.	https://www.omafra.gov.on.ca/english/engineer/facts/
5.	https://geology.com/rocks/rock-salt.shtml

Course Outcome:

CO1: To know the basic knowledge about the Climate: Classification, Global warming and climate change

CO2: Student gets knowledge on Pollution Monitoring studies.

CO3: Studnets know about the Environmental Health hazard.

CO4: Students learn the Waste management studies.

CO5: Student get involved in Medical geology applications.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	2	1	2	3	3	1	2	2	3
CO 2	3	2	1	2	3	3	1	2	2	3
CO 3	3	2	1	2	3	3	1	2	2	3
CO 4	3	2	1	2	3	3	1	2	2	3
CO 5	3	2	1	2	3	3	1	2	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOS206	**Skill Enhancement course - 1 Introduction to Geological Software**	SEC	Y	-	-	-	2	4	25	75	100
Course Objectives											
CO 1	To gain knowledge on various geological software										
CO 2	To practice with IGPET, WATEQ4F										
CO 3	To get hands on training with PHREEQC and MODFLOW										
CO 4	To apply geostistical software in data interpretation										
CO 5	To understand applications of the software used in the interpretation of the geological data										
UNIT	**Details**							**No. of Hours**		**Course Objectives**	
I	Interpretation and analysis of Geological data using MS-office, IGPET, WATEQ4F							12		CO1	
II	Applications, Principles of data input, processing, interpretation in software like PHREEQC and							12		CO2	

	MODFLOW		
III	ARCGIS, Mapinfo for spatial analysis and integration of complex geological and geophysical data. ERDAS IMAGINE as image-processing tools for analyzing remotely sensed data.	12	CO2
IV	Overview of geostatistical analysis using statistical package SPSS, Graphical analytical packages like Surfer and RockWorks for both 2-D surfaces.	12	CO2
V	Data Interpretation: Toposheets, Aerial photographs, Satellite imageries. Interpretation of Meteorology data: rainfall, temperature, wind, humidity; Interpretation of borehole logs, litho log, SP log, Resistivity log, Gamma log, neutron log.	12	CO2
	Text Books		
1.	1.Wen-Hsing Chaing & Wolgang Kinzelbach "User Manual for Processing MODFLOW", windows version 4.0,1996.		
2.	2.Sharon L. Qi, Jennifer B. Sieverling using ArcInfo to facilitate numerical modeling of ground – water flow,1997		
3.	3.Hill Mc(1992) MODFLOW – A computer program for estimating parameters of a transient, 3-D, Ground flow model using non linear regression, U.S. Geological Survey, open-file report – 91-484.		
4.	Pine,J.C, Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group(2009)		
5.	Smith K, Environmental Hazards: Assessing Risk and Reducing Disaster Rout ledge Press(2001)		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	ERDAS: IMAGE 2018, Version 16.5(V 16.5.0.82)		
2.	PHREEQC Ver.1: Ground water & pollution, II Edition: A.A. Balkana. Publication, Leiden. The Parkhurst,D.L.,1995,user's guide to PHREEQC.		
3.	Groundwater Assessment Development and Management, Karanth.K.R. (1987) Tata McGraw Hill Publishing Company, Ltd.		

Course Outcome:

CO1: Gain the knowledge of computer softwares in geology
CO2: Gain the knowledge of applications and interpretation of computer software.
CO3: Students know various geological software.
CO4: Students learn the rockworks and 2d software
CO5: Student get involved in system based analysis.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	1	2	3	3	1	2	2	3
CO 2	3	2	1	2	3	3	1	2	2	3
CO 3	3	2	1	2	3	3	1	2	2	3
CO 4	3	2	1	2	3	3	1	2	2	3
CO 5	3	2	1	2	3	3	1	2	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-III: (Second year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC301	**Core VII Geophysics**	Core	Y	-	-	-	5	6	25	75	100
Course Objectives											
CO 1	Student will able to apply geophysical methods for exploring hidden ore minerals, ground water, oil and natural gas resources.										

CO 2	Explain the principles behind different geophysical surveying techniques.		
CO 3	Process, analyze and interpret gravitational, magnetic and electromagnetic surveying data.		
CO 4	Understand the earth subsurface using electrical resistivity.		
CO 5	Describes the subsurface of the Earth in physical terms – density, electrical resistivity, magnetism, conductivity, and heat flow.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Introduction – Physical basis of geophysical exploration, various surface and sub-surface methods and their classification. Physical properties of rocks and minerals exploited in exploration and factors that control them. Geophysical anomaly, Radioactivity of rocks and ores, radioactive minerals and ores. Radiation measuring devices – Ionization chambers, gas filled (Geiger Müller) counters, scintillation counters, radiometers and γ ray spectrometers. Field radiometric methods – Air-borne surveys, automobile surveys, foot surveys.Processing and interpretation of field data.Application of radiometric methods.	12	CO1
II	Gravity Prospecting: Gravity prospecting – Principles, the Earth's gravitational field and units, its variation, Newton's Law – Geoid, spheroid and normal gravity field, figure of earth. Order of anomalies produced by geological discontinuities, absolute and relative measurement of gravity, gravimeters and their operation in the field. Field procedure, reduction and correction of gravity field data, separation of regional and residuals, upward and downward continuation, interpretation of gravity data obtained over spherical and cylindrical objects, sheet, dike and faults – Applications of gravity methods.	12	CO2
III	Electrical methods – Electrical properties of earth materials – Conduction in rocks, conduction in water-bearing rocks, description of geoelectric sections, classification of electrical methods. Resistivity method – Ohm's Law, resistivity, factors affecting resistivity, effect of homogenous earth, various configurations for resistivity methods, configuration factor, response over a layered earth. AC and DC type resistivity meters, field procedure for electrical profiling and sounding, logarithmic curve matching, advantages of plotting the	12	CO2

	data on a logarithmic graph paper. Interpretation of profiling and sounding field data, use of modelling in electrical methods, introduction to self-potential, induced polarization methods.		
IV	Seismic methods – Fundamentals of elasticity – Young's modulus, Bulk modulus, Poisson's ratio, elastic waves, laws of reflection and refraction, Huygen's principle, Fermat's principle, Principle of superposition, Seismic wave theory – Helmhotz's theorem and seismic wave propagation – Body and surface waves – Primary, Secondary, Rayleigh and Love waves – Seismic energy sources – Detectors – Seismic noises and noise profile analysis – Reduction to a datum and weathering corrections - Short period, long period, broad band and strong motion – Seismic instruments – Seismic channel – Details of geophones – Filters, Amplifier and reproducible and non-reproducible recording – Seismic timer field layout – Arc shooting – Fan shooting – Profile shooting	12	CO2
V	Data processing – Corrections applied to seismic field data , Simple interpretation of field data – Seismic refraction and reflection data processing – Applications.	12	CO2
	Text Books		
1.	Keller, G.V. and Frischknecht, F.C. (1982) Electrical Methods inGeophysical Prospecting. Pergamon Press, New York.		
2.	Rama Rao, B.S. and Murthy, I.V.R. (1978) Gravity and Magnetic Methods of Prospecting. Arnold Heinemann Publishers, New Delhi		
3.	Davies, Geoffrey F. (2001). Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press. ISBN 0-521-59067-1.		
4.	Bozorgnia, Yousef; Bertero, Vitelmo V. (2004). Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering. CRC Press.		
5.	Pedlosky, Joseph (1987). Geophysical Fluid Dynamics (Second ed.). Springer-Verlag. ISBN 0-387-96387-1.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Dobrin, M.B. (1984) An Introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.		
2.	Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D.A. (1976) Applied Geophysics. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi		
3.	Hardy, Shaun J.; Goodman, Roy E. (2005). "Web resources in the history of geophysics". American Geophysical Union. Archived from the original on 27 April 2013. Retrieved 30 September 2011.		
4.	Kivelson, Margaret G.; Russell, Christopher T. (1995). Introduction to Space Physics. Cambridge University Press. ISBN 978-0-521-45714-9.		

5.	Lowrie, William (2004). Fundamentals of Geophysics. Cambridge University Press. ISBN 0-521-46164-2
Web Resources	
1.	https://iugg.org/associations-commissions/commissions/sedi/
2.	https://iugg.org/
3.	https://www.usgs.gov/programs/geomagnetism
4.	https://www.udemy.com/course/learn-seismic-data-processing/
5.	https://seg.org/Default.aspx?TabId=176&language=en-US

Course Outcome:

CO1: Student can learn in detail about the Gravity and gravity anomalies, gravity survey, gravity map preparation

CO2: Magnetic fields, magnetic behavior of rocks, magnetic methods – anomalies, preparation of magtnetic anomaly maps

CO3: Thermal and electrical properties of rocks, resistivity method

CO4: Application of electrical method in groundwater exploration

CO5: Seismic method, wave propagation principles, seismic data interpretation.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15

Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
23GEOC302	**Core VIII Hydrogeology**	Core	Y	-	-	-	5	6	25	75	100

Course Objectives	
CO 1	To define different terms and parameters involved in Hydrogeology
CO 2	To enumerate the concept and to interpret the processes involved in groundwater
CO 3	To describe the importance of groundwater and summarise the occurrence of groundwater
CO 4	To interpret the conditions of water resources and to select some areas where the groundwater is being exploited against the natural laws
CO 5	To critically assess different factors/aspects involve

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Introduction to Hydrogeology:** Water on Earth - Types of water - Distribution of water - Hydrological cycle and its components: precipitation, evaporation, evapotranspiration, infiltration, surface runoff and sub-surface distribution and movement of ground water and their estimation for the purpose of assessing water availability. Water-bearing properties of rock formations: aquifer- isotropic and anistropic, porosity, permeability, compressibility of rocks.	12	CO1
II	**Occurrence and movement of Groundwater:** Vertical distribution of groundwater: zone of aeration and zone of saturation – Geological formations as aquifers – Springs - Darcy's experiment and its limitations, fluid pressure, hydraulic conductivity, transmissitivity – Reynolds Number - Barometric and tidal efficiency of aquifers – Ground water flow- Groundwater flow direction – Unsaturated flow –Steady and unsteady state flow.	12	CO2
III	**Water wells:** Types of wells - Well hydraulics – Cone of depression, radius of influence, drawdown and specific capacity - Drilling of shallow wells and deep wells – Well Completion – Well development – Testing wells for yield- Protection and rehabilitation of well- Collector wells and Infiltration galleries - Tracer tests and slug tests - Ground water budgeting – Ground water levels	12	CO2

	and water level maps – Safe yield and Conjunctive uses – Artificial recharge and methods.		
IV	**Groundwater Quality and Pollution:** Chemical constituents in groundwater: sources and effects - Quality criteria for different uses -Geochemical cycle of surface water and ground water- Graphical presentation of groundwater quality data- Dissolved gases in groundwater- Impact of solar energy on groundwater – Sources and causes for pollution of groundwater – Pollution attenuation – Treatment for contaminated groundwater.	12	CO2
V	**Exploration techniques and Saline water intrusion :** Methods for exploration of ground water – Geological methods, Remote Sensing techniques, geomorphological inputs, gravity, magnetic, seismic and electrical methods – Basics of ground water modeling – Physical, analog and mathematical models, finite difference modeling – Hydrogeology of arid zones of India – Hydrogeology of wetlands. Hydrodynamic equilibrium of fresh and saline water – Ghyben-Herzberg relation- Control of saline water intrusion.	12	CO2
	Text Books		
1.	Freeze, R.A. and Cherry, J.A. (1979) *Groundwater*. Prentice-Hall. London.		
2.	Fetter, C. W. (2018). *Applied Hydrogeology*.Waveland Press. ISBN: 9781478637448. 4th Edition. E-Book.		
3.	De Marsily, G., 1986. Quantitative Hydrogeology: Groundwater Hydrology for Engineers, Academic Press, Inc., Orlando Florida. — Classic book intended for engineers with mathematical background but it can be read by hydrologists and geologists as well. ISBN 0-12-208916-2		
4.	LaMoreaux, Philip E.; Tanner, Judy T, eds. (2001), Springs and bottled water of the world: Ancient history, source, occurrence, quality and use, Berlin, Heidelberg, New York: Springer-Verlag, ISBN 3-540-61841-4 Good, accessible overview of hydrogeological processes.		
5.	Porges, Robert E. & Hammer, Matthew J., 2001. The Compendium of Hydrogeology, National Ground Water Association, ISBN 1-56034-100-9. Written by practicing hydrogeologists, this inclusive handbook provides a concise, easy-to-use reference for hydrologic terms, equations, pertinent physical parameters, and acronyms		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Todd, D.K. and Mays, L.W. (2013)*Groundwater Hydrology*.John Wiley & Sons, New York. ISBN: 978-81-265-3003-8. 3rd Edition.		
2.	Davis and DeWeist. (1966).*Geohydrology*. John Wiley & Sons, New York.		
3.	Domenico, P.A. & Schwartz, W., 1998. Physical and Chemical Hydrogeology Second Edition, Wiley. — Good book for consultants, it has many real-world examples and covers additional topics (e.g. heat flow, multi-phase and unsaturated flow). ISBN 0-471-59762-7		
4.	Driscoll, Fletcher, 1986. Groundwater and Wells, US Filter / Johnson Screens. —		

	Practical book illustrating the actual process of drilling, developing and utilizing water wells, but it is a trade book, so some of the material is slanted towards the products made by Johnson Well Screens. ISBN 0-9616456-0-1
5.	Anderson, Mary P. & Woessner, William W., 1992 Applied Groundwater Modeling, Academic Press. — An introduction to groundwater modeling, a little bit old, but the methods are still very applicable. ISBN 0-12-059485-4
Web Resources	
1.	https://iah.org/
2.	http://www.groundwateruk.org/
3.	https://gw-project.org/books/groundwater-resource-development.
4.	https://www.epa.gov/dwreginfo/drinking-water-regulations.
5.	https://www.guidelinegeo.com/groundwater-prospection

Course Outcome:

CO1: This study helps to understand the Hydrological cycle, Aquifer; flow rates and flow directions , Groundwater fluctuation: types, controlling factors
CO2: Occurrence and movement of Groundwater
CO3: Groundwater wells, types and methods
CO4: Groundwater chemistry: Components of groundwater Groundwater pollution: Arsenic, fluoride and Nitrate
CO5 Salinity in Groundwater, Seawater intrusion and Ghyben-Herzberg Relation

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	1	2	3	3	3	2
CO 2	3	3	3	2	1	2	2	3	3	2
CO 3	3	3	3	2	2	3	2	3	3	3
CO 4	3	3	3	3	2	3	2	3	3	3
CO 5	3	3	3	3	2	3	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3

CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
23GEOP303	**Core IX Geophysics Practical**	Core	Y	-	-	-	5	6	25	75	100

Course Objectives	
CO1	To describe the different geophysical methods
CO2	To identify the groundwater potential zone by resistivity survey
CO3	Understand gravity survey
CO4	To interpret magnetic data
CO5	To preparation of geophysical maps

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Electrical Resistivity methods**: Interpretation of vertical electrical sounding data obtained over 2- and 3-layered earth using the S-line, curve matching and auxiliary point chart method – Field demonstration of resistivity, seismic SP and magnetic prospecting techniques. .	12	CO1
II	**Gravity Methods:** Computation of gravity response over a sphere – Exercises on drift correction, separation of regional and residual of gravity data – Contouring of gravity data – Calibration of magnetometer – Interpretation of field magnetic data over a dike. Interpretation of seismic refraction data obtained over 2- and 3-layered earth – Computation of configuration constant.	12	CO2
III	**Magnetic methods:** Magnetic, methods problems and applications.	12	CO2

IV	**Seismic methods:** Seismic survey data interpretaions, problems and applications.	12	CO2
V	Preparation of geophysical anomaly maps, Isoresistivity maps.	12	CO2
	Text Books		
1.	Brooks, A.R. (1972), Geobotany and Biogeochemistry in mineral exploration, Harper and Row.		
2.	D.A. Cox, (1995), The elements of Earth , Oxford University Press, New York		
3.	Dobrin, M.B. (1960), Introduction to Geophysical prospecting, , Mc Graw Hill Book Co., New Delhi.		
4.	Mathew N.O,Sadiku, 2007.Elements of Electromagnetics,., Fourth edition, Oxford University Press.		
5.	Parasnis, D.S. (1975). Principles of Applied Geophysics, Chapman and Hall. Pacal, 2nd Ed. 1977.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Govett, G.J.S. (Ed) (1983). Handbook of Exploration Geochemistry, Elsevier		
2.	Hawkes, H.E. and Webb, (1965), Geochemistry in Mineral Exploration, Harper and Row Publishers.		
Web Resources			

Course Outcome:

CO1: The student will be able to understand the Electrical Resistivity methods
CO2: Understand the application of near surface geophysical techniques for aquifer characterization.
CO3: Student gain knowledge on Interpretation of field magnetic data
CO4: Students get knowledge on Magnetic, methods problems
CO5: Student learn about Isoresistivity maps.

Mapping with Programme Outcomes:
Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	3	2	2	3	3	3
CO 2	3	3	3	3	3	2	3	3	3	3
CO 3	2	3	3	3	3	1	2	3	3	3
CO 4	2	3	3	3	3	1	2	3	3	3
CO 5	2	3	3	3	3	1	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOP304	**Core X Applied Hydrogeology Practical**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives	
CO1	To gain knowledge on aquifer parameters
CO2	To understand flow discharge methods
CO3	Understand how groundwater infiltrates and flows through Earth materials
CO4	To interpret groundwater flow direction from the topographic features
CO5	To critically assess the quality of groundwater

UNIT	Details	No. of Hours	Course Objectives
I	**Aquifers and Aquitards:** Factors affecting infiltration and ground water flow: Porosity – Permeability - Grain size – Specific yield – Specific retention – Hazen method for Hydraulic conductivity – Storativity.	12	CO1
II	**Groundwater flow:** Specific discharge – Average linear velocity – Flow net – Flow across water table –Steady unidirectional flow – Unsteady radial flow.	12	CO2
III	**Water chemistry: S**olubility –Ionic strength of	12	CO2

	groundwater - Trilinear diagram – Oxidation potential *Eh.*		
IV	**Laboratory**: Chemical analysis of major dissolved constituent of groundwater by titrimetric method. Chemical analysis of major dissolved constituent of groundwater by spectrophotometric method. Chemical analysis of major dissolved constituent of groundwater by flame photometric method. Determination and calculation of Water quality parameters pH, EC, TDS. Calculation of SAR, TH, NCH, TDS, EC and interpretation for various uses	12	CO2
V	**Laboratory**: Uses of Multiparameter – On field water parameter analysis techniques – Preparation of standards for analysis.	12	CO2
	Text Books		
1.	Freeze, R.A. and Cherry, J.A. (1979) *Groundwater*. Prentice-Hall. London.		
2.	Fetter, C. W. (2018). *Applied Hydrogeology*.Waveland Press. ISBN: 9781478637448. 4th Edition. E-Book.		
3.	De Marsily, G., 1986. Quantitative Hydrogeology: Groundwater Hydrology for Engineers, Academic Press, Inc., Orlando Florida. — Classic book intended for engineers with mathematical background but it can be read by hydrologists and geologists as well. ISBN 0-12-208916-2		
4.	LaMoreaux, Philip E.; Tanner, Judy T, eds. (2001), Springs and bottled water of the world: Ancient history, source, occurrence, quality and use, Berlin, Heidelberg, New York: Springer-Verlag, ISBN 3-540-61841-4 Good, accessible overview of hydrogeological processes.		
5.	Porges, Robert E. & Hammer, Matthew J., 2001. The Compendium of Hydrogeology, National Ground Water Association, ISBN 1-56034-100-9. Written by practicing hydrogeologists, this inclusive handbook provides a concise, easy-to-use reference for hydrologic terms, equations, pertinent physical parameters, and acronyms		
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1.	Todd, D.K. and Mays, L.W. (2013)*Groundwater Hydrology*.John Wiley & Sons, New York. ISBN: 978-81-265-3003-8. 3rd Edition.		
2.	Domenico, P.A. & Schwartz, W., 1998. Physical and Chemical Hydrogeology Second Edition, Wiley. — Good book for consultants, it has many real-world examples and covers additional topics (e.g. heat flow, multi-phase and unsaturated flow). ISBN 0-471-59762-7		
3.	Driscoll, Fletcher, 1986. Groundwater and Wells, US Filter / Johnson Screens. — Practical book illustrating the actual process of drilling, developing and utilizing water wells, but it is a trade book, so some of the material is slanted towards the products made by Johnson Well Screens. ISBN 0-9616456-0-1		

4.	Anderson, Mary P. & Woessner, William W., 1992 Applied Groundwater Modeling, Academic Press. — An introduction to groundwater modeling, a little bit old, but the methods are still very applicable. ISBN 0-12-059485-4
Web Resources	
1.	https://iah.org/
2.	https://gw-project.org/books/groundwater-resource-development/
3.	https://info.aquaclara.org/what-are-the-most-common-water-contaminants
4.	https://www.usgs.gov/mission-areas/water-resources

Course Outcome:

CO1: The student will be able to understand aquifer parameters calculation.
CO2: Understand the significance of groundwater flow
CO3: Student gain knowledge on groundwater quality plots
CO4: student get knowledge on Aquifers and Aquitards studies
CO5: Student learn about Water quality analysis techniques.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	3	2	2	3	3	3
CO 2	3	3	3	3	3	2	3	3	3	3
CO 3	2	3	3	3	3	1	2	3	3	3
CO 4	2	3	3	3	3	1	2	3	3	3
CO 5	2	3	3	3	3	1	2	3	3	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE305	Elective V Economic Geology	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	To provide knowledge on economically relevant minerals and metals
CO2	To explain the Ore genesis responsible for the economic deposits
CO3	To provide practical knowledge on the minerals and metals
CO4	Detail on the methods applied for mineral exploration
CO5	To summarise the radioactive mineral deposits

UNIT	Details	No. of Hours	Course Objectives
I	**Ore Genesis**. Ore deposits and ore minerals. Magmatic processes of mineralization. Porphyry, skarn and hydrothermal mineralization. Fluid inclusion studies, sedimentary, supergene enrichment, placer. Mineralisation associated with – (i) ultramafic, mafic and acidic rocks (ii) greenstone belts (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism. Magma related mineralization through geological time. Stratiform and stratabound ores. Ores and metamorphism – cause and effect relations. Metallogeny and mineral belts. SedEx deposits.	12	CO1
II	**Mineral Exploration**. Principles of mineral prospecting and exploration - conceptualization, methodology and stages; sampling, subsurface sampling including pitting, trenching and drilling, core and non-core drilling, planning of bore holes and location of bore holes on ground. Core logging, geochemical exploration- nature of samples anomaly, strength of anomaly and controlling factors, coefficient of aqueous migration.	12	CO2
III	Mineralogy and geochemistry of radioactive minerals. Origin and Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods for prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Radioactive	12	CO2

	methods in petroleum exploration — well logging techniques. Nuclear waste disposal — geological constraints.		
IV	**Coal and petroleum Geology**. Coal and its properties: Different varieties and ranks of coal. Origin of coal. Coalification process and its causes. Fundamentals of coal petrology. Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Structural, stratigraphic and mixed traps. Techniques of exploration. Methods of petroleum exploration. Petroliferous basins of India.	12	CO2
V	**Industrial Geology**. Identification and description of ore and industrial minerals. Geological studies in Coal industries; Petroleum industries; Geological investigation in mining industries. Need of Geologist in industrial sectors. Role of geologist in NLC, ONGC, GSI, WIHG, NIO, NGRI, PRL, RRL, Soil Survey of India, BSIP, Archaeological survey of India.	12	CO2
	Text Books		
1.	Banerjee, P. K. and Ghosh, S. (1997) Elements of Prospecting for Non-Fuel Mineral Deposits. Allied Publishers Ltd., New Delhi.		
2.	Chatterjee, K. K. (1993) An Introduction to Mineral Economics. Wiley Eastern Ltd., New Delhi.		
3.	Krishnasamy S, India's Mineral Resources, Oxford & IBH. Delhi(1988)		
4.	Sharma N.L&R.K.Sinha. Mineral Economics, Oxford & IBH. Delhi(1985)		
5.	Prasad U, Economic Mineral Deposits, CBS. Delhi (2003)		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Krishnaswamy, S. (1979) India's Mineral Resources. Oxford-IBH Publishers, New Delhi.		
2.	Bateman, A. M. and Jensen, M. L. (1981) Economic Mineral Deposits. John Wiley & Sons, New York		
3.	Industrial Minerals , Sinha,R.K,(1986), Oxford 7 IBH Pub. Co., New Delhi.		
4.	Craig,R.C& D.V. Vaughan. Ore Microscopy and Ore Petrography. Wiley. New York.(1985)		
5.	Aiyengar, N.K.N, Minerals of Madras, Dept.of Industries &Commerce. Guindy, Madras, (1964).		
Web Resources			
1.	https://www.britannica.com/topic/economic-geology		
2.	https://en.m.wikipedia.org/wiki/supergene-(geology)		

3.	https://energymining.sa.gov.au/minerals/mineral-commodities
4.	https://www.slideshare.net/mobile/monokaonaBoruah/magmatic-deposits-economic-geology
5.	https://link.spring.com/

Course outcome:

CO1: Students will have the knowledge and skills to recognise common ore minerals in hand samples and under the microscope.
CO2: Demonstrate familiarity with a wide range of mineral deposits, including recognising the overall geometry, zonation and alteration patterns associated with specific classes of metallic mineral deposits,
CO3: To get awareness on geochemistry of radioactive minerals
CO4: Fundamentals of coal petrology, Gain knowledge on the Origin, migration and entrapment of natural hydrocarbons
CO5: Student learns more knowledge on industrial aspects in geological studies.

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3

CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
23GEOS306	**Skill Enhancement course – II** Field studies, written report and evaluation	SEC	Y	-	-	-	3	4	25	75	100

SEMESTER-III: INTERNSHIP (II year)

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
23GEOI307	**INTERNSHIP**	Int	Y	-	-	-	2	-	25	75	100

Course Objectives			
	The students will enhance their writing skills.		
	They will acquire knowledge about writing their assignments.		
	They will delve into unchartered territory with regard to Scientific/Technical writing of research papers/reports.		
	The students will understand what is Bibliography, how to cite references and how to quote them in the text.		
	They will be trained in how to avoid redundancies, which constitute a major problem while writing a Scientific Paper/Technical Report.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	The Pre-Writing Stage: Why Write?-What is a Scientific Paper?-What is a Technical Report? Planning The Scientific Paper or ReporT: Structure-Headings-Note for	12	CO1

	Framework-Format-Keeping a Card Index-Assembling the Data. Contents Of Scientific Papers; The Parts of a Scientific Paper-Preliminaries-Text-End Material		
II	Contents Of Technical Reports: Types of Reports-Investigations-Proposals-Progress Reports-Information-Feasibility Study-Alternative Order. Illustrations and Tables: Maps-Line Drawings-Graphs-Photographs-Current Practices on Illustrations-tables.	12	CO2
III	Style and Form: Accuracy of Content-Clarity and simplicity of Expression-Coherence-Conciseness-Logical Sequence. Aids To Writing: Grammar and Usage-Abbreviations-Compounding of words-Placement of Phrases- Italics-Numerical Expressions-Units and Symbols-Punctuation-Spelling-Conclusion.	12	CO2
IV	Writing Practices: Rewriting-Readability-Checklist-Preparation of Final Manuscript. On Proof Reading: Proof reading Requirements-Proof Reading Symbols-Modern Methods of MS Preparation. About Publishing: Procedures-Double Publishing-Authorship-Copyright-Cataloguing- Guarantees-Reproduction of Published Material-Royalty-Conference Proceeding.	12	CO2
V	Refrees, Formats And Proofs: Duties of a Referee-Standard Format Requirements-Editing of Proofs. Oral And Poster Presentations: Preamble-Mode of Oral Presentation-Aids to Oral Presentation-Poster Presentation. Project Proposals: Types of Project Proposals- The Strategy Project Proposals-Some formats of Project Proposals- Project Proposal Evaluation-Examples of Evaluations.	12	CO2
1.	Whitesides, G. Writing a Scientific Paper Full text. Originally presented at the 231st National Meeting of the American Chemical Society (ACS) in Atlanta, GA, March 26-30, 2006. Division of Chemical Information, CINF 17.		
2.	The Science of Scientific Writing Full textan article by George Gopen and Judith Swan, published in American Scientist, Vol. 78, No. 6 (November-December 1990), pp. 550-558.		
References Books **(Latest editions, and the style as given below must be strictly adhered to)**			
1.	Guide to Scientific and Technical Writing - P. G. Cooray 1992. ISBN - 9559543407, 9789559543404, 159 pages		
Web Resources			

1.	https://www.springer.com/journal/12594

Course Outcome:

CO1: students understand the basis of writing skills.
CO2: students practice how to write the technical reports
CO3: Students learn about the styles and form , grammar, spelling and conclusion
CO4: Student gain about the writing practices
CO5: Understand to prepare the poster presentation and preparation of project proposals

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	2	3	3	3	3	3	1	3	3
CO 4	2	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	3	3	3	2	3

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Semester-IV: (Second year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC401	**Core XI : Applied Geochemistry**	Core	-	-	-	-	5	5	25	75	100

Course Objectives	
CO1	To know understand the origin of geochemical elements.
CO2	To understand the geochemical differentiation of elements.
CO3	To gain knowledge on geochemical exploration.
CO4	To know geochemical sampling techniques.
CO5	To prepare Geochemical anomaly maps.

UNIT	Details	No. of Hours	Course Objectives
I	Geochemistry, Introduction, definition, aim and scope. Origin and abundance of elements. Distribution of elements in lithosphere. Geochemical cycle.	12	CO1
II	Geochemical classification of elements. Geochemical differentiation of elements in exogenic and endogenic cycle. Redox reactions and Eh-pH diagrams and their applications.	12	CO2
III	Geochemical Exploration: Introduction, Principles of geochemical exploration, geochemical environment mobility, stability of minerals, geochemical association. Methods of surveying and sampling: Anomalies, background value, threshold value, path finder elements. Study of primary and secondary patterns dispersion forms and patterns,	12	CO2
IV	Methods of geochemical exploration-I: (a) Lithogeochemical prospecting (b) Hydrogeochemical prospecting. Anomalies in Residual overburden. Leachedore outcrops, Gossans and Residual soils transported overburden.	12	CO2
V	Methods of geochemical exploration-II:(a) Biogeochemical prospecting, Geobotanical prospecting. Geochemical trace element indicators and their significance. Geochemical anomaly map concept,	12	CO2

	preparation, and interpretation of anomalies for identification of potential mineralized zones.		
1.	Fyfe, W.S.1964, Geochemistry of solids. Mc Graw Hill Book Co.,		
2.	Goldschmidt, V.M.1954, Geochemistry, Oxford University press.		
3.	Krauskopf..K.B , 1986, Introduction to geochemistry, , Mc Graw Hill.		
4.	Mason, B.1971, Principles of Geochemistry, John Wiley & Sons.		
5.	Mason,B. and Moore.C.B. 1991, Introduction to Geochemistry, Wiley Eastern		
5.	Rankama and Sahama, (1950), Geochemistry, University of Chickago Press,		
7.	Misra K.C. (2005) Introduction To Geochemistry: Principles And Applications.Wiley India.		
8.	William M. White (2013) Geochemistry. Wiley-Blackwell.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	H.E. Hawkes, J.S. Webb. 1979. Geochemistry in Mineral Exploration,: Academic Press, London		
2.	Jenners, 1987. Geochemical exploration, Universal Books Distributors Co.,		
3.	Kovalevskii, A.L. 1979, Biogeochemical exploration for mineral deposits, Oxonian press.		
4.	Arthur Brownlow 1982, Geochemistry, Prentice Hall		
Web Resources			
1.	https://link.springer.com/chapter/10.1007/		
2.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/		
3.	https://www.google.com/ur1?sa=t&source=web&rct=j&ur1=https//mines.gov.in/		
4.	https://www.ncbi.nml.gov/books/		
5.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/		

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	2	3	3	3	2	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	2	3	2
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	2	3	3	2	3	3	2	3

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOC402	Core XII Engineering and Mining Geology	Core	Y	-	-	-	5	6	25	75	100

Course Objectives	
CO1	To enumerate the different aspects of engineering geology
CO2	To briefly summarise the properties and significance of different Earth materials on the basis of engineering geology
CO3	To briefly summarise the properties and significance of different Earth materials on the basis of engineering geology
CO4	To employ the students in geotechnical investigations and make them understand the various mining methods adopted in addition to estimation of ore reserves
CO5	To theories the knowledge

UNIT	Details	No. of Hours	Course Objectives
I	Engineering geology: Engineering properties of rocks, soft sediments and soils – Geological investigations pertaining to bridges, buildings, dams, highways and airfields – Types of reservoirs – Geological investigations of reservoir sites.	12	CO1
II	Problems pertain to tunneling in hard and soft grounds – Geological investigations preceding tunneling – Geological investigations pertaining to harbors, docks, coastal erosion – Shoreline engineering – Construction of retaining walls – Problems and solutions.	12	CO2
III	Mining geology: Terminology used in metal mines – Terminology used in coal mines – Prospecting and exploration – Alluvial mining methods – Quarrying – Opencast mining – Mine supports – Mine atmosphere.	12	CO2
IV	Methods of underground metal mining: Without artificial supports – With artificial supports – Cut and fill methods – Shrinkage stoping – Caving methods.	12	CO2
V	Coal mining: Longwall advancing – Longwall retreating – Board and Pillar method – Horizon mining.	12	CO2

	Text Books
1.	Arogyaswamy, R.N.P. (1996) *Courses in Mining Geology*. 4th Edition. Oxford and & IBH Publishing Co., New Delhi.
2.	Peters, W.C. (1978) *Exploration and Mining Geology*. 2nd Edition. John Wiley & Sons, New York
3.	Vitousek P.M, Global Change and Natural Resource Management, Beyond global warming:Ecology and global change. Ecology 75, 1861-1876.
4.	Miller T.G. Jr, Environmental Science, Wadsworth Publishing Co. (TB)
5.	Thomas,R.T, Introduction to Mining methods, McGraw Hill, New York(1986)
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Blyth, F.G.H. (1963) *A Geology for Engineers*. 4th Edition. The ELBS & Edward Arnold (Publishers) Ltd., London
2.	Legget, H.F. and Hatheway, A.W. (1988) *Geology and Engineering*. 3rd Edition. McGraw-Hill Book Co., New York
3.	Arogya swamy R.N.P, Courses in Mining Geology, Oxford &IBH, New Delhi(1988)
4.	Singh, R.D, Coal Mining, New Age Publishers, Delhi(1998)
5.	Hartman, H.L, SME Mining Engineering Handbook, SME Colorado, USA (1992)
Web Resources	
1.	https://link.springer.com/chapter/10.1007/
2.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/
3.	https://www.google.com/ur1?sa=t&source=web&rct=j&ur1=https//mines.gov.in/
4.	https://www.ncbi.nml.gov/books/
5.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/

Course Outcome:

CO1: Students can understand the Engineering properties of rocks

CO2: student can apply the knowledge and ideals on geological investigations for constructions

CO3: Getting knowledge about the alluvial mining methods

CO4: Study the methods of underground metal mining

CO5: Understand the knowledge about the coal mining methods and techniques

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	3	3	1	2	3	1	2	1	3
CO 2	2	3	3	1	2	3	1	2	1	3
CO 3	2	3	3	1	2	3	1	2	1	3

CO 4	2	3	3	1	2	3	1	2	1	3
CO 5	2	3	3	1	2	3	1	2	1	3

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

S-Strong-3 ; M-Medium -2 ; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOD403	**Project with viva-voce**	Core	Y	-	-	-	7	10	25	75	100

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOE404	**Elective VI Petroleum Exploration and Mud logging**	Elective	Y	-	-	-	3	4	25	75	100
Course Objectives											
CO1	To Identify and enumerate the methods of drilling. To describe and explain the oil resources. To summarize the whole procedure involved in exploitation of oil										

	resources		
CO2	To interpret and select the prospering area for exploitation of		
CO3	Compare and contrast the differences between prosperous and non-economical sites.		
CO4	Critically assess and review the ideas at strategic situation at the drilling site		
CO5	Can make hypothesis to achieve the target		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Petroleum Exploration – Petroleum Geology - Applied Mathematics in Petroleum Engineering. Oil Field Drilling – Onshore and Offshore Drilling - Drilling Rigs – Well Types - The Drill String – Drill Bits – Well Profile- Bore-hole volume Calculation and Displacement – Lag time – Basic Hydraulics - Drilling Fluids - Formation Pressure –Bore Hole Problems - Coring – Objective of Coring and Core Analysis- Casing and Cementing – Fishing - Well Completion – Well Testing.	12	CO1
II	Basics of Mudlogging –Surface Logging - Tasks and Responsibilities - Geological Surveillance – Cutting Sampling - Collection, Examination – Lithological and Mineralogical Description–Calcimetry - Oil Shows-Fluorescence and Cut Fluorescence – Thin Sections – Chemical Tests – Gas Sampling – Hydrocarbon Gas Analysis – Pore Pressure calculation - Cutting Evaluation – Sample Examination Procedure - Wellsite Geo-Chemistry - Gases other than Hydrocarbons, Communication Skill - QHSE – Worksite Environmental Hazards – Offshore Safety - Quality Control.	12	CO2
III	MudloggingServices, Mudlogging Sensors –Operations – Maintenance - Inspection and calibrations–Trouble shooting - Technical Specification - Reporting - Final Well Reports - Mudlogging Unit Installation and Maintenance.Practical Mudlogging, Lab Training on Rig up and Rig Down of Sensors, Equipment and Monitoring Realtime drilling followed by a Rig site Visit.	12	CO3
IV	Down-hole Measurement - Measuring While Drilling (MWD) – MWD Principle – Telemetry Types – Formation Evaluation MWD- Sensor information – Natural Gama ray – Formation resistivity – Focused Current Resistivity (FCR) – Toroidal Resistivity – Electromagnetic Wave Propagation Resistivity –	12	CO4

	Multiple Propagation Resistivity (MPR) – Geo-Steering-Neutron Porosity MWD Tools – Formation Density MWD Tools – Drilling Performance MWD.		
V	Down-hole Logging - Logging While Drilling (LWD) – Temperature Logs – Caliper Logs – Self Potential Logs (SP) – Resistivity & Conductivity Logs – Gama ray and Spectral Gama ray logs – Sonic Logs – Density and Photo Electric factor Logs – The Neutron Log – The dip meter – Imaging Logs –MDT Sampling - Lithology reconstruction from Logs- Facies Sequences and depositional environments from Logs – Sequence Stratigraphy and Stratigraphy.	12	CO5

1.	Levorsen, A.J. (2004). *Geology of Petroleum*, CBS Publishers and Distributors Pvt Ltd., Chennai. 2nd Edition.
2.	Bhagwan Sahay. (1997). *Petroleum Exploration and Exploitation Practices*, Allied Publishers Limited, Chennai. 2nd Edition.
3.	Geology& Mineral Resources of the States of India. Misc Pub.No.30.Geological Survey of India. Kolkota. (Several individual volumes available online at GSI portal) GSI(2005).
4.	The Mudlogging Handbook – Alun Whittaker
5.	Brian Frehner. Finding Oil: The Nature of Petroleum Geology, 1859–1920 (University of Nebraska Press; 2011) 232 p

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Mudlogging Training Manuals – GEOLOG International B.V
2.	The Mudlogging Handbook – Alun Whittaker
3.	An Introduction in Stratigraphy, Stamp L.D, (1964), Thomas Murby, Museum St, WCI, London.
4.	Stratigraphic Principles and Practices, Weller, J.M, (1962), Harper & Bros, New York
5.	Wadia,D.N, Geology of India, McMillan India Delhi(1953)

Web Resources

1.	https://stratigraphy.org/
2.	https://www.sepm.org/
3.	https://www.geosocindia.org/
4.	https://www.moes.gov.in/
5.	https://isegindia.org/

Course Outcome:

CO1: Students gain knowledge about the Petroleum Exploration
CO2 Students learn about the Basics of Mudlogging
CO3: Students get knowledge on MudloggingServices, Mudlogging Sensors –Operations – Maintenance
CO4: Students know about the Down-hole Measurement
CO5: Students able to learn on Down-hole Logging

Mapping with Programme Outcomes:

Map course outcomes for each course with programme outcomes (PO) in the 3-point scale of Strong, Medium and Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	3	3	3	3	3	3	3	2	3
CO 2	2	3	3	3	3	3	3	3	2	3
CO 3	2	3	3	3	3	3	3	3	2	3
CO 4	2	3	3	3	3	3	3	3	2	3
CO 5	2	3	3	3	3	3	3	3	2	3

S-Strong-3; M-Medium -2; L-Low-1.

Program Specific Outcomes

CO/PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course contribution to Pos	3.0	3.0	3.0	3.0	3.0

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOS405	Skill Enhancement Course - III / professional competency skills / Geological tour	SEC	Y	-	-	-	2	4	25	75	100

Semester-IV: Extension activity (II Year)

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
23GEOX406	**Extension activity**	EA	Y	-	-	-	1	-	25	75	100

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