UNIVERSITY OF CALICUT

B.Sc. GEOLOGY HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

Board of Studies in Geology (Single Board)

B.Sc. GEOLOGY HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

PO1	Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc Geology Honours programme at Calicut University, a student would:

PSO1	Understand Earth processes, including plate tectonics, sedimentation, magmatism, and metamorphism, and be able to apply this knowledge to interpret geological phenomena and history.
PSO2	Have a deep understanding of Earth materials, including minerals, rocks, ores and their economic importance.
PSO3	Have a profound knowledge about origin and geologic evolution of Indian subcontinent with particular reference to geochronology, stratigraphy and fossil content.
PSO4	Demonstrate proficiency in conducting geological fieldwork, including the ability to identify and interpret various geological formations, collect samples effectively, and to create geological maps.
PSO5	Be able to assess geological hazards and contribute to sustainable resource management practices through responsible decision-making.
PSO6	Be able to integrate knowledge from other disciplines such as physics, chemistry, and engineering with geological principles to address climate change, natural resource exploration, and environmental remediation.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Academic Pathway</th><th>Major</th><th>Minor/ Other Disciplines</th><th rowspan="2">Foundation Courses
AEC: 4
MDC: 3
SEC: 3
VAC: 3
Each course has 3 credits</th><th rowspan="2">Intern -ship</th><th rowspan="2">Total Credits</th><th rowspan="2">Example</th></tr>
<tr><td colspan="2">Each course has 4 credits</td></tr>
<tr><td>1</td><td>Single Major (A)</td><td>68
(17 courses)</td><td>24
(6 courses)</td><td>39
(13 courses)</td><td>2</td><td>133</td><td>Major: Geology + six courses in different disciplines in different combinations</td></tr>
<tr><td>2</td><td>Major (A) with Multiple Disciplines (B, C)</td><td>68
(17 courses)</td><td>12 + 12
(3 + 3 = 6 courses)</td><td>39
(13 courses)</td><td>2</td><td>133</td><td>Major: Geology + Chemistry and Physics/Statistics/ Mathematics</td></tr>
<tr><td>3</td><td>Major (A) with Minor (B)</td><td>68 (17 courses)</td><td>24
(6 courses)</td><td>39
(13 courses)</td><td>2</td><td>133</td><td>Major: Geology
Minor: From any other Major</td></tr>
<tr><td>4</td><td>Major (A) with Vocational Minor (B)</td><td>68
(17 courses)</td><td>24
(6 courses)</td><td>39
(13 courses)</td><td>2</td><td>133</td><td>Major: Geology
Minor: From any other Major</td></tr>
<tr><td>5</td><td>Double Major (A, B)</td><td>A: 48 (12 courses)
B: 44 (11 courses)</td><td>-</td><td>12 + 18 + 9</td><td>2</td><td>133</td><td>Geology and Chemistry double major</td></tr>
<tr><td colspan="6">The 24 credits in the Minor stream are distributed between the two Majors.

2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133)

1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)</td></tr>
<tr><td colspan="8">Exit with UG Degree / Proceed to Fourth Year with 133 Credits</td></tr>
</table>

B.Sc. GEOLOGY HONOURS PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	GEL1CJ 101/ GEL1MN 100	Core Course 1 in Major – Introduction to Geology	75	5	4	30	70	100
		Minor Course 1	60/ 75	4/ 5	4	30	70	100
		Minor Course 2	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1– English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 1 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	GEL2CJ 101/ GEL2MN 100	Core Course 2 in Major – Processes at the Earth's Surface	75	5	4	30	70	100
		Minor Course 3	60/ 75	4/ 5	4	30	70	100
		Minor Course 4	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3– English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 2 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	GEL3CJ 201	Core Course 3 in Major – Introductory Geoinformatics	60	4	4	30	70	100
	GEL3CJ 202/ GEL 3MN200	Core Course 4 in Major – Crystallography & Stratigraphy	75	5	4	30	70	100
		Minor Course 5	60/ 75	4/ 5	4	30	70	100

		Minor Course 6	60/ 75	4/ 5	4	30	70	100
		Multi-Disciplinary Course 3 – Kerala Knowledge System	45	3	3	25	50	75
	ENG3FV 108(2)	Value-Added Course 1 – English	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**
4	GEL4CJ 203	Core Course 5 in Major – Geoinformatics & Field Geology – I**	75	5	4	30	70	100
	GEL 4CJ 204	Core Course 6 in Major – Mineralogy	75	5	4	30	70	100
	GEL4CJ 205	Core Course 7 in Major – Sedimentary Petrology & Palaeontology	75	5	4	30	70	100
	ENG4FV 109(2)	Value-Added Course 2 – English	45	3	3	25	50	75
		Value-Added Course 3 – Additional Language	45	3	3	25	50	75
	ENG4FS 111(2)	Skill Enhancement Course 1 – English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	GEL5CJ 301	Core Course 8 in Major – Geoinformatics & Field Geology -II**	75	5	4	30	70	100
	GEL5CJ 302	Core Course 9 in Major – Igneous Petrology	75	5	4	30	70	100
	GEL5CJ 303	Core Course 10 in Major – Metamorphic Petrology	60	4	4	30	70	100
		Elective Course 1 in Major	60	4	4	30	70	100
		Elective Course 2 in Major	60	4	4	30	70	100
		Skill Enhancement Course 2	45	3	3	25	50	75
		Total		**25**	**23**			**575**
6	GEL6CJ 304/ GEL8MN 304	Core Course 11 in Major – Economic Geology	75	5	4	30	70	100
	GEL6CJ 305/ GEL8MN 305	Core Course 12 in Major– Structural Geology & Geotectonics	75	5	4	30	70	100
	GEL6CJ 306/ GEL8MN 306	Core Course 13 in Major – Indian Geology	60	4	4	30	70	100

		Elective Course 3 in Major	60	4	4	30	70	100
		Elective Course 4 in Major	60	4	4	30	70	100
	GEL6FS 113	Skill Enhancement Course 3 – Content Writing in Geology	45	3	3	25	50	75
	GEL6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
7	GEL7CJ 401	Core Course 14 in Major – Hydrogeology	75	5	4	30	70	100
	GEL7CJ 402	Core Course 15 in Major – Applied Geomorphology	75	5	4	30	70	100
	GEL7CJ 403	Core Course 16 in Major – Advanced Palaeontology	75	5	4	30	70	100
	GEL7CJ 404	Core Course 17 in Major – Marine Geology	75	5	4	30	70	100
	GEL7CJ 405	Core Course 18 in Major – Advanced Mineralogy & Crystallography	75	5	4	30	70	100
		Total		**25**	**20**			**500**
8	GEL8CJ 406 / GEL8MN 406	Core Course 19 in Major – Geoinformatics Applications	75	5	4	30	70	100
	GEL8CJ 407 / GEL8MN 407	Core Course 20 in Major – Engineering Geology	60	4	4	30	70	100
	GEL8CJ 408 / GEL8MN 408	Core Course 21 in Major – Exploration Geology	60	4	4	30	70	100
	OR (instead of Core Courses 19 – 21 in Major)							
	GEL8CJ 449	Project (in Honours programme)	360*	13*	12	90	210	300
	GEL8CJ 499	Research Project (in Honours with Research programme)	360*	13*	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100

		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	GEL8CJ 489	Research Methodology in Geology	60	4	4	30	70	100
		Total		**25**	**24**			**600**
Total Credits for Four Years					**177**			**4425**

* The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

**The practical component of the course will be a fieldwork for eight to nine days including six working days. This can be carried out anytime during the semester.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	**Major Courses**	**Minor Courses**	**General Foundation Courses**	**Internship/ Project**	**Total**
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
* instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN GEOLOGY FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	GEL1CJ 101/ GEL1MN 100	Core Course 1 in Major – Introduction to Geology	5	4
2	GEL2CJ 101/ GEL2MN 100	Core Course 2 in Major – Processes at the Earth's Surface	5	4
3	GEL3CJ 201	Core Course 3 in Major – Introductory Geoinformatics	4	4
	GEL3CJ 202/ GEL3MN 200	Core Course 4 in Major – Crystallography & Stratigraphy	5	4
4	GEL4CJ 203	Core Course 5 in Major – Geoinformatics & Field Geology - I	5	4
	GEL4CJ 204	Core Course 6 in Major – Mineralogy	5	4
	GEL4CJ 205	Core Course 7 in Major – Sedimentary Petrology & Palaeontology	5	4
5	GEL5CJ 301	Core Course 8 in Major – Geoinformatics & Field Geology -II	5	4
	GEL5CJ 302	Core Course 9 in Major – Igneous Petrology	5	4
	GEL5CJ 303	Core Course 10 in Major – Metamorphic Petrology	4	4
		Elective Course 1 in Major	4	4
		Elective Course 2 in Major	4	4
6	GEL6CJ 304/ GEL8MN 304	Core Course 11 in Major – Economic Geology	5	4
	GEL6CJ 305/ GEL8MN	Core Course 12 in Major– Structural Geology & Geotectonics	5	4

	305			
	GEL6CJ 306/ GEL8MN 306	Core Course 13 in Major – Indian Geology	4	4
		Elective Course 3 in Major	4	4
		Elective Course 4 in Major	4	4
	GEL6CJ 349	Internship in Major	-	2
Total for the Three Years				**70**
7	GEL7CJ 401	Core Course 14 in Major – Hydrogeology	5	4
	GEL7CJ 402	Core Course 15 in Major – Applied Geomorphology	5	4
	GEL7CJ 403	Core Course 16 in Major – Advanced Palaeontology	5	4
	GEL7CJ 404	Core Course 17 in Major – Marine Geology	5	4
	GEL7CJ 405	Core Course 18 in Major – Advanced Mineralogy & Crystallography	5	4
8	GEL8CJ 406 / GEL8MN 406	Core Course 19 in Major – Geoinformatics Applications	5	4
	GEL8CJ 407 / GEL8MN 407	Core Course 20 in Major – Engineering Geology	4	4
	GEL8CJ 408 / GEL8MN 408	Core Course 21 in Major – Exploration Geology	4	4
	OR (instead of Core Courses 19 – 21 in Major)			
	GEL8CJ 449	Project (in Honours programme)	13	12
	GEL8CJ 499	Research Project (in Honours with Research programme)	13	12
		Elective Course 5 in Major	4	4
		Elective Course 6 in Major	4	4
		Elective Course 7 in Major	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)			

	GEL8CJ 489	Research Methodology in Geology	4	4
Total for the Four Years				**114**

Note:

i. Choose any two elective courses each from the course basket of 4 elective courses in semester 5 & 4 elective courses in semester 6.

ii. Choose any three elective courses from the course basket of 6 elective courses in semester 8, as listed below in the table of elective courses with no specialisation

ELECTIVE COURSES IN GEOLOGY WITH SPECIALISATION

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**Field Techniques**								
	1	**GEL5EJ 301**	Mine Planning & Resource Estimation	5	60	4	4	30	70	100
	2	**GEL5EJ 302**	Geotechnical Engineering	5	60	4	4	30	70	100
	3	**GEL6EJ 301**	Survey Techniques	6	60	4	4	30	70	100
	4	**GEL6EJ 302**	Offshore Mineral Resources & Mining	6	60	4	4	30	70	100
2		**Environment & Climate**								
	1	**GEL5EJ 303**	Environmental Geology	5	60	4	4	30	70	100
	2	**GEL5EJ 304**	Natural Disaster Management	5	60	4	4	30	70	100
	3	**GEL6EJ 303**	Environmental Impact Assessment	6	60	4	4	30	70	100
	4	**GEL6EJ 304**	Geology & Climate Change	6	60	4	4	30	70	100

ELECTIVE COURSES IN GEOLOGY WITH NO SPECIALISATION

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
1	**GEL8EJ 401**	Climatology	8	60	4	4	30	70	100
2	**GEL8EJ 402**	Environmental Informatics	8	60	4	4	30	70	100
3	**GEL8EJ 403**	Remote Sensing for Geology	8	60	4	4	30	70	100
4	**GEL8EJ 404**	Oceanography	8	60	4	4	30	70	100
5	**GEL8EJ 405**	Analytical techniques in Geology	8	60	4	4	30	70	100
6	**GEL8EJ 406**	Introduction to Soil Science	8	60	4	4	30	70	100

GROUPING OF MINOR COURSES IN GEOLOGY

(Title of the Minor: **GEOLOGY)**

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**Geoinformatics** (For students other than Geology Major)								
	1	GEL1MN 101	Geoinformatics - 1	1	75	5	4	30	70	100
	2	GEL2MN 101	Geoinformatics – 1I	2	75	5	4	30	70	100
	3	GEL3MN 201	Geoinformatics – 1II	3	75	5	4	30	70	100

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
2		**Basic Geology** (For students other than Geology Major)								
	1	GEL1MN 102	Physical Geology	1	75	5	4	30	70	100
	2	GEL2MN 102	Geomorphology	2	75	5	4	30	70	100
	3	GEL3MN 202	Historical Geology	3	75	5	4	30	70	100

i. From the minor groups given above maximum one group (3 courses) can be offered to students who have taken Geology as their discipline.

ii. Students in Single Major pathway can choose course/courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

iii. Students in Major with Multiple Disciplines pathway can choose as one of the multiple disciplines, all the three courses from any one of the Minor/ Vocational Minor groups offered by a discipline, other than their Major discipline.

iv. Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by a discipline other than their Major discipline. If the students from other Major disciplines choose the two Minor groups in Geology as given above, then the title of the Minor will be **Geology**.

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN GEOLOGY

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	GEL1FM 105	Multi-Disciplinary Course 1 – Exploring the Mother Earth	45	3	3	25	50	75
2	GEL2FM 106	Multi-Disciplinary Course 2 – Minerals, Rocks & Fascinating Plate Tectonics	45	3	3	25	50	75
3	GEL3FV 108	Value-Added Course 1 – Geology & Sustainable Development Goals	45	3	3	25	50	75
4	GEL4FV 110	Value-Added Course 2 –Water Conservation Techniques	45	3	3	25	50	75
5	GEL5FS 112	Skill Enhancement Course 2 – Water Quality Assessment	45	3	3	25	50	75
6	GEL6FS 113	Skill Enhancement Course 3 – Content Writing in Geology	45	3	3	25	50	75

COURSE STRUCTURE FOR BATCH A1(B2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Geology (Major A) ***B1: 68 credits in Major B***

A2: 53 credits in Geology (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	*GEL1CJ 101/ GEL1MN 100	Core Course 1 in Major Geology– Introduction to Geology	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	GEL1CJ 102/ GEL2CJ 101/ GEL2MN 100	Core Course 2 in Major Geology – Processes at the Earth's Surface (for batch A1 only)	75	5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	GEL1FM 105	Multi-Disciplinary Course 1 – Exploring the Mother Earth (for batch A1 only)	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
2	GEL2CJ 102/ GEL3CJ 202/ GEL3MN 200	Core Course 3 in Major Geology – Crystallography & Stratigraphy	75	5	4	30	70	100
	BBB2CJ 101	Core Course 2 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB2CJ 102 / BBB1CJ 102	Core Course 3 in Major B – (for batch B2 only)	60/ 75	4/ 5	4	30	70	100

	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
	GEL2FM 106	Multi-Disciplinary Course 2 in Geology – Minerals, Rocks & Fascinating Plate Tectonics	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
3	**GEL3CJ 201**	Core Course 4 in Major Geology – Introductory Geoinformatics	60	4	4	30	70	100
	GEL3CJ 203/ GEL4CJ 204	Core Course 5 in Major Geology – Mineralogy	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 1 in B –	45	3	3	25	50	75
	GEL3FV 108	Value-Added Course 1 in Geology – Geology & Sustainable Development Goals (for batch A1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**22**			**550**
4	**GEL4CJ 201**/ GEL4CJ 205	Core Course 6 in Major Geology – Sedimentary Petrology & Palaeontology	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
	GEL4CJ 202/ GEL4CJ 203	Core Course 7 in Major Geology – Geoinformatics & Field Geology – I (for batch A1 only)	75	5	4	30	70	100
	GEL4FV 110	Value-Added Course 2 in Geology – Water Conservation Techniques	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 1 in B –	45	3	3	25	50	75

	GEL5FS 112	Skill Enhancement Course 1 in Geology – Water Quality Assessment	45	3	3	25	50	75
		Total		**23/ 24**	**21**			**525**
5	**GEL5CJ 301**	Core Course 8 in Major Geology – Geoinformatics & Field Geology -II	75	5	4	30	70	100
		Core Course 7 in Major B –	60/ 75	4/ 5	4	30	70	100
	GEL5CJ 304/ GEL5CJ 303	Core Course 9 in Major Geology – Metamorphic Petrology (for batch A1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Geology	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	**GEL6CJ 301** GEL5CJ 302	Core Course 10 in Major Geology – Igneous Petrology	75	5	4	30	70	100
		Core Course 8 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB6CJ 305	Core Course 9 in Major B – (for batch B2 only)	60	4	4	30	70	100
		Elective Course 2 in Major Geology	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	GEL6FS 113	Skill Enhancement Course 2 in Geology– Content Writing In Geology (for batch A1 only)	45	3	3	25	50	75
	GEL6CJ 349	Internship in Major Geology (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

For batch A1(B2), the course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6.

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH A1(B2)
IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in Geology	General Foundation Courses in Geology	Internship/ Project in Geology	Major Courses in B	General Foundation Courses in B	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	3	-	4 + 4	-	3 + 3	21
3	4 + 4	3	-	4 + 4	3	-	22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in Geology	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

COURSE STRUCTURE FOR BATCH B1(A2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Geology (Major A) ***B1: 68 credits in Major B***

A2: 53 credits in Geology (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	**GEL1CJ 101**/ GEL1MN 100	Core Course 1 in Major Geology – Introduction to Geology	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	Core Course 2 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	BBB1FM 105	Multi-Disciplinary Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
2	**GEL2CJ 101**/ GEL2MN 100	Core Course 2 in Major Geology – Processes at the Earth's Surface	75	5	4	30	70	100
	BBB2CJ 101	Core Course 3 in Major B –	60/ 75	4/ 5	4	30	70	100
	GEL2CJ 102/ GEL3CJ 202/ GEL3MN 200	Core Course 3 in Major Geology – Crystallography & Stratigraphy (for batch A2 only)	75	5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75

		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
	GEL1FM 105	Multi-Disciplinary Course 1 in Geology –Exploring the Mother Earth	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
3	**GEL3CJ 201**	Core Course 4 in Major Geology – Introductory Geoinformatics	60	4	4	30	70	100
	GEL3CJ 203/ GEL4CJ 204	Core Course 5 in Major Geology – Mineralogy	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 2 in B –	45	3	3	25	50	75
	BBB3FV 108	Value-Added Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**22**			**550**
4	**GEL4CJ 201/** GEL4CJ 205	Core Course 6 in Major Geology – Sedimentary Petrology & Palaeontology	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
		Core Course 7 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	GEL4FV 110	Value-Added Course 2 in Geology – Water Conservation Techniques	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 2 in B –	45	3	3	25	50	75
	GEL5FS 112	Skill Enhancement Course 1 in Geology – Water Quality Assessment	45	3	3	25	50	75
		Total		**22 – 24**	**21**			**525**

5	**GEL5CJ 301**	Core Course 7 in Major – Geoinformatics & Field Geology -II	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
		Core Course 9 in Major B – (for batch B1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Geoloy	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	**GEL6CJ 301**/ GEL5CJ 302	Core Course 8 in Major – Igneous Petrology	75	5	4	30	70	100
		Core Course 10 in Major B –	60/ 75	4/ 5	4	30	70	100
	GEL6CJ 302 GEL5CJ 303	Core Course 9 in Major Geology – Metamorphic Petrology (for batch A2 only)	60	4	4	30	70	100
		Elective Course 2 in Major Geology	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	BBB6FS 113	Skill Enhancement Course 2 in B – (for batch B1 only)	45	3	3	25	50	75
	BBB6CJ 349	Internship in Major B (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

To continue to study Geology in semesters 7 and 8, batch B1(A2) needs to earn additional 15 credits in Geology to make the total credits of 68. Suppose this condition is achieved, and the student of batch B1(A2) proceeds to the next semesters to study Geology. The course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6, taking into account the number of courses in Geology taken online to earn the additional 15 credits.

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH B1(A2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Geology	General Foundation Courses in Geology	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in B	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.

2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.

- In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
- In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.

3. All the 3-credit courses (General Foundational Courses) in Geology are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
		20	10	10	20*
	Total	30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.

- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Geology or allied disciplines.
2. There should be minimum 60 hours of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc. Geology Honours programme, institute/ industry visit is a requirement for the completion of Internship. The internship can be carried out in a geologic organization, Geological research institute, research laboratory or place of geologic importance. A brief report of the internship has to be submitted with photos and analysis.
5. The students should make regular and detailed entries in to a personal log book throughout the period of internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
6. The log book and the typed report must be submitted at the end of the Internship.
7. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and Viva-voce	5	
3		Punctuality and Log Book	5	
4	Report of Institute Visit/ Study Tour		5	10%
5	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	6	35%
6		Presentation of the work	5	
7		Viva-voce	6	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		8	15%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution or any other higher educational institution (HEI) or research centre/ training centre.
- A project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.

- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Geology or allied disciplines.
2. Project should be done individually.
3. Project work can be of fieldwork-based/experimental/ theoretical/computational in nature.
4. There should be minimum 240 hours of engagement from the student in the Project work in Honours programme.

5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.

6. The various steps in project works are the following:
    - Wide review of a topic.
    - Investigation on a problem in systematic way using appropriate techniques.
    - Necessary fieldwork and data collection
    - Systematic recording of the work.
    - Reporting the results with interpretation in a standard documented form.
    - Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.

- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Geology are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Geology	Internal Marks of a General Foundation Course of 3-credits in Geology	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
		20	5
	Total	25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail

9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):
  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

$$\text{i.e. SGPA (Si)} = \Sigma i\ (Ci \times Gi) / \Sigma i\ (Ci)$$

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semester}}{\text{Total credits in that semester}}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in six semesters}}{\text{Total credits in six semesters (133)}}$$

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in eight semesters}}{\text{Total credits in eight semesters (177)}}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

Major Courses

Semester I

Programme	B. Sc. Geology				
Course Code	GEL1CJ101				
Course Title	**INTRODUCTION TO GEOLOGY**				
Type of Course	**Major**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	This course serves as an introduction to the field of geology, covering fundamental concepts related to Earth's formation, dimensions, dynamic evolution, geochronology, and major geological hazards.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will have an understanding of the basic principles and concepts of geology, including the formation of Earth and its dimensions.	U	F	Exam
CO2	Students will be able to explain the theories of Earth's formation and its physical dimensions, including the structure and composition of Earth's interior layers.	Ap	C	Home assignments
CO3	Students will analyze the dynamic processes that have shaped Earth's surface and interior over geological time scales, including plate tectonics, mountain building, erosion, and sedimentation.	An	P	Seminar presentations
CO4	Students will be able to interpret geochronological data and understand the methods used to determine the ages of rocks	E	M	Home assignments
CO5	Students will identify and describe major geological hazards, including earthquakes, volcanic eruptions, and understand the geological processes that cause them.	Ap	F	Assignment
CO6	Students will evaluate strategies for mitigating the impacts of geological hazards on society and the environment.	E	M	Practical Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: INTRODUCTION TO GEOLOGY

Module	Unit	Content	Hrs	Marks
I	**Introduction to Geology**		**10**	**15**
	1	Geology: The Science of Earth	2	
	2	The Development of Geology	3	
	3	The Nature of Scientific Inquiry	2	
	4	Plate Tectonics and Scientific Inquiry	3	
II	**Earth's Formation and Dimensions**		**15**	**20**
	5	Earth's Spheres	3	
	6	Earth System	3	
	7	Evolution of Earth	2	
	8	Formation of Earth's layered structure	2	
	9	Earth's Internal Structure	2	
	10	Layers defined by Physical Properties	3	
III	**Changing Earth & Geochronology**		**10**	**15**
	11	The Rock Cycle	2	
	12	The face of Earth. Mountain building. Origin & evolution of ocean floor	2	
	13	Age of the earth	2	
	14	Dating methods: Absolute (radiometric) and relative (stratigraphy)	2	
	15	Application of dating methods in constructing the Geological Time Scale	1	
	16	Overview of eras, periods, epochs – major geological events.	1	
IV	**Introduction to Major Geological Hazards**		**10**	**20**
	17	Volcanoes & Volcanic Hazards	1	
	18	Nature of Volcanic Eruptions and Products	1	
	19	Types of Volcanoes & Volcanic Landforms	2	
	20	Earthquakes & Earthquake Hazards	2	
	21	Seismology, Seismic Waves, Earthquakes & Plate Boundaries	2	
	22	Earthquake Destruction. Prediction, Forecast and Mitigation	2	
V	**Practical**		**30**	**20**
	1	Lab exercises to apply the concepts of interior of earth, earth's magnetism and plate tectonics. Exploring geologic features using Google Earth.	20	
	2	Introduction to Topographic Maps. Exercises involving contour lines.	4	
	3	Application of Gt.Aide (Academy) Freeware	6	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	4 Theory Modules (10)	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Condie, K.C., 2015. *Earth as an Evolving Planetary System,* 3rd Edition, Academic Press,USA.
2. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. PearsonEducation Inc., New Jersey, USA
3. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
4. Wicander, R. and Monroe, J., 2006. *Essentials of Geology.* 4th Edition, Thomson LearningInc., USA.
5. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA

Semester II

Programme	B. Sc. Geology				
Course Code	GEL2CJ101				
Course Title	**PROCESSES AT THE EARTH'S SURFACE**				
Type of Course	**Major**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	0	2	75
Pre-requisites	NIL				
Course Summary	This course summarises the actions of various geological agents responsible for the formation of landforms. The processes and features produced thereof is explained in this geomorphology course.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Assess the various exogenous process in molding the earth's surface	Ev	C	Exams/ Quiz
CO2	Examine the origin, types, and effects of mass wasting	An	C	Assignment/ Exams
CO3	Distinguish various morphological features resulting from geological actions of running water.	Un	C	Practical Assignment/Exams
CO4	Describe the basic concepts on the distribution and occurrence of groundwater	An	C	Assignments/ Exams
CO5	Distinguish various morphological features resulting from geological actions of wind and glacier.	An	C	Practical Assignment /Exams
CO6	Distinguish various morphological features of ocean floor and coastal region resulting from geological processes	Un	P	Practical Assignment/ Internal exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: PROCESSES AT THE EARTH'S SURFACE

Module	Unit	Content	Hrs	Marks
I		**Mass Wasting & Running Water**	**10**	**25**
	1	The Importance of Mass Wasting. Landslides as Geologic Hazards	1	
	2	Mass Wasting in Landform Development	1	
	3	Controls and Triggers of Mass Wasting	2	
	4	Hydrologic Cycle. Drainage basin and drainage patterns	2	
	5	Graded, Braided, and Meandering streams	1	
	6	Geological work of streams: Erosional and depositional fluvial landforms	2	
	7	Base level, Rejuvenation, Knick Points, River Piracy	1	
II		**Groundwater**	**10**	**10**
	8	Underground water: Occurrence.Water table, porosity, permeability	3	
	9	Aquifers: Confined and unconfined, aquicludes, aquitard, and aquifuge.	3	
	10	Natural Springs and types	2	
	11	Geological work of groundwater, Karst Topography	2	
III		**Glacier & Wind**	**15**	**20**
	10	Ice Sheets. Types of glaciers	2	
	11	Formation and movement of glacial ice	2	
	12	Glacial erosion and features produced by glacial erosion	3	
	13	Glacial deposits. Concept of ice ages.	2	
	14	Global distribution of deserts. Formation of deserts.	2	
	15	Geological actions of wind: erosion, transportation & deposition	2	
	16	Processes and features associated with wind action	2	
IV		**Oceans**	**10**	**15**
	17	Oceans and Seas –distribution over earth	1	
	18	Waves, tides, currents, CCD, Marine sediments.	2	
	19	Types of continental margins	1	
	20	Ocean bottom topography.	2	
	21	Shoreline processes	2	
	22	Shoreline features	2	
V		**Practical**	**30**	**20**
	1	Stream ordering using toposheets	5	
	2	Google Earth application in understanding the global distribution of glaciers, deserts and oceans	20	
	3	Calculations involving sediment and water movement in streams	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to PhysicalGeology. 9th Edition, Pearson Education, Inc., New Jersey, USA.

2. Wicander, R. and Monroe, J., 2006. Essentials of Geology. 4th Edition, Thomson Learning Inc., USA

Semester III

Programme	B. Sc. Geology				
Course Code	GEL3CJ201				
Course Title	**INTRODUCTORY GEOINFORMATICS**				
Type of Course	Major				
Semester	I				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	NIL				
Course Summary					

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will acquire knowledge of the key sciences and technologies involved in geoinformatics	U	F	Exam
CO2	Students will learn about the origin and development of GIS, its components and its core functions	Ap	C	Quiz
CO3	Students will understand the advantages and limitations of different GIS platforms	An	P	Assignment
CO4	Students will understand the principles and techniques of map-making, and map projection types	E	M	Viva
CO5	Students will grasp the fundamental concepts of remote sensing	Ap	F	Assignment
CO6	Students will be able to define and explain the meaning and scope of geoinformatics, and understand its importance in various fields	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: INTRODUCTORY GEOINFORMATICS

Module	Unit	Content	Hrs	Marks
I	**Introduction to GIS**		**15**	**20**
	1	Geoinformatics –Definition & scope		
	2	Sciences and technologies involved – Remote Sensing, GIS, Cartography, Photogrammetry		
	3	Origin and development of GIS		
	4	GIS – definition		
	5	Components – hardware, software, people, methods, data		
	6	Functions – data input and output, visualization, editing, analysis, map design		
	7	Desktop GIS, mobile GIS, web GIS		
	8	Limitations of GIS		
II	**Maps**		**10**	**15**
	9	Maps – to convey location and extent, characteristics, and spatial relationships		
	10	Classification of maps – topographic maps, thematic maps, cadastral maps		
	11	Elements of a map		
	12	Classification of projection – Cylindrical, Conical, Azimuthal		
	13	Map design		
III	**Introduction to Remote Sensing**		**15**	**20**
	14	History of Remote Sensing		
	15	Introduction to aerial photography: overlaps, flight lines, drift, crab, tilt, dead ground		
	16	Geometry of aerial photographs - scale, principal point, perspective centre, fiducial marks, nadir, focal length, airbase, photo base, isocentre, relief displacement.		
	17	Vertical & oblique aerial photographs		
	18	Visual image interpretation & elements of interpretation - tone, texture, shape, association, pattern, shadow, size		
	19	Stereoscopy - Pocket Stereoscope, Mirror Stereoscope, Parallax Bar		
IV	**Concept of Remote Sensing**		**8**	**15**
	20	Stages in Remote Sensing		
	21	Energy Source – EMR, characteristic of EMR –wave nature and particle nature. EMR spectrum		
	22	Blackbody radiation, Stefan Boltzmann's law, Wein's displacement law		
	23	Interaction of EMR with atmosphere – reflection, scattering, absorption		
	24	Interaction of EMR with earth's surface features – reflection, transmission		
	25	Spectral Reflectance of land covers – Vegetation, Soil, Water		
V	**Open Ended Module**		**12**	**10**
	1	Interpretation of aerial photographs		
	2	Interpretation of toposheets		
	3	Downloading of toposheets from various websites		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Lo, C.P. and Yeung, A.K.W., 2007. Concepts and Techniques in GeographicInformation Systems.

Programme	B. Sc. Geology				
Course Code	GEL3CJ202				
Course Title	**CRYSTALLOGRAPHY & STRATIGRAPHY**				
Type of Course	Major				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	The course has two parts. First part deals with classification of crystals into various systems and classes. Second part is an introduction to geoinformatics.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will be able to identify the basic crystal systems	U	F	Exam
CO2	Students will be able to identify the different forms present in crystals, based on their symmetry elements	Ap	C	Quiz
CO3	The students will be able to define various laws of stratigraphy	An	P	Assignment
CO4	The students will be able to differentiate physical and biological criteria of correlation	E	C	Viva
CO5	The students will be able to explain major events of mass extinction	Ap	F	Assignment
CO6	The students will be able to explain different types of stratigraphic classification	E	F	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: CRYSTALLOGRAPHY & STRATIGRAPHY

Module	Unit	Content	Hrs	Marks
I		**Introduction to Crystallography and Symmetry Elements**	**10**	**15**
	1	Scope and applications of crystallography. Symmetry elements in crystallography	1	
	2	Crystallographic axes, notation, parameter system of Weiss and Miller indices. Axial ratio	2	
	3	Laws of crystallography	2	
	4	Symmetry elements and forms of Normal, pyritohedral, tetrahedral, and plagiohedral classes in the Cubic system		
	5	Symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Sphenoidal, and Trapezohedral classes in the Tetragonal system		
II		**Symmetry Elements and Forms in Various Systems**	**15**	**25**
	6	Symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Trapezohedral, Rhombohedral, Rhombohedral Hemimorphic, and Trapezohedral classes in the Hexagonal system	3	
	7	Symmetry elements and forms of Normal and Sphenoidal classes in the Orthorhombic system	4	
	8	Symmetry elements and forms of Normal classes in the Monoclinic and Triclinic systems	4	
	9	Twin crystals. Definitions and effects of twinning	4	
	10	Laws of twinning, composition plane, twinning plane, and twinning axis		
	11	Indices of twins: simple and repeated (polysynthetic twins), contact and penetration twins (secondary twins)		
III		**Stratigraphy**	**8**	**12**
	12	Laws of Stratigraphy: Concept of uniformitarianism	2	
	13	Law of order of superposition, Law of faunal succession and Law of original horizontality	1	
	14	Principle of Lateral Continuity, Principle of Inclusion, Law of cross-cutting relationship	2	
	15	Correlation: Physical criteria of correlation	1	
	16	Biological criteria of correlation and homotaxis		
IV		**Stratigraphy**	**12**	**18**
	17	Major events of Mass extinction: Ordovician-Silurian and late Devonian extinction events	2	
	18	Permian- Triassic and Cretaceous- Tertiary extinction events	3	
	19	Facies and facies changes: Litho and bio facies	3	
	20	Break in stratigraphic records: Unconformities and diastems	3	
	21	Stratigraphic classification: Biostratigraphic classification: Biozones, biohorizon, index fossil. Range zone, taxon range zone, concurrent range zone, interval zone, assemblage zone, Acme zone	3	
	22	Lithostratigraphic classification: Group, Formation, Member, Bed. Chronostratigraphic classification: Eonothem, erathem, system, series, stage	3	
V		**Practical**	**30**	**10**
	1	Practical involving identification of crystal forms of normal classes of all systems		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Borchardt-Ott, W., 2011. Crystallography– An Introduction. Springer Heidelberg, 355p.
2. Dana, F.S., 1955. A Text Book of Mineralogy. Asia publishing House, Wiley.
3. Klen, C., Hurlbut, C.S., 1985. Manual of Minerology, John Wiley & Sons
4. Perkins, D., 2015. Mineralogy. Pearson Education (3Ed), 568 p
5. Boggs, S., 2016. Principles of Sedimentology and Stratigraphy. Pearson Education. 568 p.
6. Brookfield, M.E., 2003. Principles of Stratigraphy. Wiley-Blackwell, 340 p.
7. Nichols, G., 2016. Sedimentology and Stratigraphy. Wiley-Blackwell, 419 p.

Semester IV

Programme	B. Sc. Geology				
Course Code	GEL4CJ203				
Course Title	**GEOINFORMATICS & FIELD GEOLOGY - I**				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Students should have completed all the core courses in the previous 3 semesters.				
Course Summary	Field Geology is a hands-on course designed to provide undergraduate students with practical experience in geological fieldwork. Through field trips, mapping exercises, and data collection activities, students will learn essential field techniques, geological mapping skills, and interpretation of geological features and structures.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate proficiency in field techniques for geological mapping and data collection.	U	F	Exam
CO2	Identify and describe geological formations, rock types, and structural features in the field.	Ap	C	Quiz
CO3	Apply the techniques of GIS for map making	An	P	Assignment
CO4	Apply the techniques of remote sensing for field based studies	E	M	Viva
CO5	Collaborate effectively in fieldwork teams and communicate geological findings through field reports and presentations.	Ap	F	Assignment
CO6	Develop critical thinking and problem-solving skills through hands-on field experiences.	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: GEOINFORMATICS & FIELD GEOLOGY -I

Module	Unit	Content	Hrs	Marks
I	**Introduction**		**6**	**10**
	1	Importance of field work in geological exploration	1	
	2	Introduction to field equipment and tools	1	
	3	Principles of geological mapping	1	
	4	Topographic map interpretation	1	
	5	Compass and GPS navigation techniques	2	
II	**Geological Mapping**		**10**	**16**
	6	Use of Brunton Compass	2	
	7	Measurement and recording of structural data in the field – Strike & Dip	2	
	8	Introduction to structural map symbols	2	
	9	Field identification of common minerals	2	
	10	Hand specimen identification – important textures in igneous, sedimentary &metamorphic rocks	2	
III			**14**	**24**
	11	Topographical maps, Thematic maps, Geologic maps & Existing digital map sources	2	
	12	Data models in GIS. Spatial data model – Raster & Vector. Attribute data model – hierarchical, network, relational.	3	
	13	Data base management system. Data management in GIS	3	
	14	Data editing: Detecting and correcting errors;	2	
	15	Data reduction, Generalization, Transformation;	2	
	16	Rubber Sheeting and edge matching	2	
IV	**Geological structures & Measurements**		**15**	**20**
	17	Types of platforms – Groundborne, Airborne ,Space-borne.	2	
	18	Orbital elements - six elements of Keplerian orbit.	2	
	19	Types of satellite orbits – Sunsynchronous, Geosynchronous	2	
	20	GNSS – GPS, GAGAN	4	
	21	Classification of sensors. Multispectral sensors – pushbroom & whiskbroom scanners. Atmospheric sensors, SONAR, LiDAR	2	
	22	Sensor parameters – spatial, spectral, radiometric, temporal. Hyperspectral imaging	3	
V	**Practical**		**30**	**10**
	The practical component of this course will be carried out as a fieldwork programme covering various geological formations across India. The actual days of field work should be 6 to 7 days excluding travel period.			

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ Mid semester Exam	5	Mark for practical work will be awarded based on students' performance during field work.
2	Seminar/ Viva/ Quiz	3	
3	Assignment	2	

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Basic Geological Mapping. Richard J. Lisle, Peter Brabham, and John W. Barnes (2011), Wiley-Blackwell. ISBN: 978-0470686345
2. Geological Field Techniques. Tom McCann (2012). Springer. ISBN: 978-9400739156
3. Field Geology Illustrated. Terry S. Maley (1994), Mineral Land Publications ISBN: 978-0962517130
4. Geology in the Field. Robert R. Compton (1985) John Wiley & Sons, ISBN: 978-0471842245
5. Field Geology. Frederic H. Lahee (1961) McGraw-Hill, ISBN: 978-0070355918.

Programme	B. Sc. Geology				
Course Code	GEL4CJ204				
Course Title	**MINERALOGY**				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	GEL1CJ101 – Introduction to Geology				
Course Summary	This course introduces the students to the world of minerals. The microscopic observation and description of important rock forming silicates are the core of this course.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will develop proficiency in identifying hand specimens of minerals.	U	F	Exam
CO2	Students will develop proficiency in using petrographic microscopes and identify minerals in thin sections	Ap	C	Quiz
CO3	Students will learn to identify common rock-forming minerals based on their optical properties	An	P	Assignment
CO4	Students will be able to classify minerals into appropriate mineral groups based on their chemical composition and other important properties.	E	M	Viva
CO5	Students will understand the significance of mineralogy in the context of geological processes	Ap	F	Assignment
CO6	Students will understand the role of minerals in rock and ore formation.	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: MINERALOGY

Module	Unit	Content	Hrs	Marks
I		**Physical and Chemical Mineralogy**	**9**	**15**
	1	Definition of Mineral . Scope and aim of Mineralogy.	2	
	2	Crystal Coordination - the making of minerals	1	
	3	Compositional variation and coupled ionic substitution, Isomorphism, Polymorphism, Pseudomorphism.	2	
	4	Solid solution and ex- solution in minerals.	1	
	5	Physical properties of minerals- form, colour, streak, lustre, hardness, cleavage, fracture, specific gravity, tenacity, transparency	2	
	6	Electrical and gagnetic properties- pyro and piezo electricity, ferri-, para-, and diamagnetism.	1	
II		**Petrological Microscopy and Optical Properties of Minerals**	**10**	**20**
	7	Nature of light, Ordinary and polarized light, Refraction and reflection	1	
	8	Refractive index, critical angle, and total internal reflection	1	
	9	Polarisation ,double refraction, Nicol Prism	2	
	10	Petrological microscope and its parts	1	
	11	Optical properties of minerals	2	
	12	Properties under open & crossed nicols	2	
	13	Isotropic and anisotropic minerals	1	
III		**Study of mineral groups**	**6**	**10**
	14	Classification and structural diversity of silicate minerals	2	
	15	Chemistry, structure, and physical properties of Olivine & Garnet families	2	
	16	Chemistry, structure, and physical properties of Epidote group & Aluminium silicates	2	
IV		**Study of mineral groups**	**20**	**25**
	17	Chemistry, structure, and physical properties of Pyroxenes & Pyroxenoids	3	
	18	Structure, chemistry and physical properties of Amphibole family	3	
	19	Structure, chemistry, and physical properties of Mica, Chlorite, and polymorphs of Quartz.	3	
	20	Structure, chemistry, and physical properties of Feldspars, Feldspathoids, and Spinel.	4	
	21	Chemistry, optical and physical properties of Scapolite, Cordierite, Talc, Serpentine, Calcite, Dolomite, Topaz, Staurolite, Beryl, Tourmaline, Fluorite, Apatite, Zircon, Rutile, Sphene, Zeolites, and Corundum	4	
	22	Modes of occurrences and industrial uses.	3	
V		**Practical**	**30**	**10**
	1	Identification of hand specimens of important rock forming minerals	15	
	2	Identification of thin sections of important rock forming minerals	15	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Dyar, M.D., Gunter, M.E., 2007. Mineralogy and Optical Mineralogy. Min. Soc. America, 705p.

2. Demange, M., 2012. Mineralogy for Petrologists: Optics, Chemistry, and Occurrence of Rock Forming Minerals. CRC Press (Taylor & Francis Group), 182p.

3. Nesse, W.D., 2012. Introduction to Optical Mineralogy. Oxford University Press; 4 Edition, 384p.

4. Pichler, H., Riegraf, C.S., 2011. Rock-forming Minerals in Thin Section. Springer, 220 p.

5. Deer, W.A., Howie, R.A., Zussman, J., 2013. Introduction to the Rock-forming Minerals. Mineralogical Society of Great Britain & Ireland, 510 p.

Programme	B. Sc. Geology				
Course Code	GEL4CJ205				
Course Title	**SEDIMENTARY PETROLOGY & PALAEONTOLOGY**				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge on sedimentation, invertebrate organisms, and taxonomic classification of organisms				
Course Summary	The course deals with various sedimentary processes, sedimentary textures & structures, and classification of sedimentary rocks. It also discusses the taxonomic classification, geological history, and stratigraphic importance of the invertebrate fossils of Protozoa, Coelenterata, Hemichordata, Mollusca, Brachipoda, Echinodermata and Arthropoda.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Illustrate various sedimentary processes, sedimentary textures and structures, and classify the sedimentary rocks	U	F&C	Class tests/Quiz
CO2	Distinguish different sedimentary depositional environments and sedimentary deposits	U	C	Class tests/Quiz/ Seminars
CO3	Discuss the general morphology, classification and the stratigraphic importance of the phylum: Protozoa, Coelenterate and Hemichordata	R	F	Class tests/ Assignments
CO4	Illustrate the general morphology, classification and the stratigraphic importance of the phylum: Mollusca, and Brachiopoda	R	F	Class tests/ Assignments
CO5	Describe the general morphology, classification and the stratigraphic importance of the phylum: Echinodermata and Arthropoda	R	F	Class tests/ Assignments
CO6	Distinguish the			

	sedimentary rocks based on their physical and optical properties, and identify the fossils of invertebrate organisms	Ap	F&P	Lab tests

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: SEDIMENTARY PETROLOGY & PALAEONTOLOGY

Module	Unit	Content	Hrs	Marks
I		**Sedimentary processes, sedimentary textures & structures, and sedimentary rocks**	**10**	**15**
	1	Sedimentary processes: disintegration & decomposition of rocks, transportation, deposition, diagenesis	3	
	2	Textures of sedimentary rocks: clastic and non-clastic textures	2	
	3	Structures of sedimentary rocks: mechanical, chemical, and organic structures	2	
	4	Classification of sedimentary rocks	3	
II		**Depositional Environments and Types of Sedimentary Deposits**	**12**	**20**
	5	Introduction to depositional environments: terrestrial, marine, and transitional	4	
	6	Mechanical sedimentary deposits: rudaceous, arenaceous, and argillaceous	2	
	7	Chemical sedimentary deposits: siliceous, carbonaceous, ferruginous, and salt deposits	2	
	8	Organic sedimentary deposits: calcareous, siliceous, phosphatic and carbonaceous deposits	2	
	9	Residual sedimentary deposits: terra rossa, clay, laterite, bauxite, and soils, and heavy mineral deposits	2	
III		**Invertebrate Paleontology - Protozoa, Coelenterata, and Hemichordata**	**10**	**20**
	10	Fossils & Fossilisation: Petrifaction, permineralization, carbonization, recrystallization, silicification, amber preservation, mummification. Types and uses of fossils.	4	
	11	Phylum Protozoa - Order Foraminifera General morphology - chitinous test, septa, arrangement of chambers, suture, aperture; and dimorphism of foraminifera. Classification, geological history, and stratigraphic importance of Foraminifera	2	
	12	Phylum Coelenterata - Class Anthozoa Zoological features, general morphology: corallum, corallite, theca, chambers, septa, fossula, columella; and septal developments	2	
	13	Classification of corals - tabulate corals and rugose corals, their evolution, geological distribution and stratigraphic importance	1	
	14	Subphylum Hemichordata - Class Graptozoa.General morphology: rhabdosome, stipe, theca, common canal, nema, virgula, sicula, angle of divergence, and central disc Classification, geological distribution and stratigraphic importance of Graptozoa	1	
IV		**Invertebrate Paleontology - Mollusca and Brachiopoda**	**13**	**20**

	15	Phylum Mollusca - Class Pelecypoda Morphology: umbo, hinge line, ligament, lunule, escutcheon, adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation	2	
	16	Classification and geological history of Pelecypoda	1	
	17	Phylum Mollusca - Class Gastropoda General morphology: shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus, peristome and types of coiling Classification and geological history of Gastropoda	2	
	18	Phylum Mollusca - Class Cephalopoda General morphology, siphuncle, septa, septal necks, connecting rings, chambers, suture lines, shell forms and ornamentation	2	
	19	Classification and geological history of Cephalopoda	1	
	20	Phylum Mollusca - Phylum Brachiopoda General morphology: umbo, hinge line, pedicle opening, delthyrium, deltidium, pseudo deltidium, brachial skeleton and ornamentation	2	
	21	Classification and geological history of Brachiopods	1	
	22	Phylum Arthropoda - Class Trilobita General morphology: Cephalon, thorax and pygidium Classification and geological history of Trilobites	2	
V	**Practical**		**30**	**10**
	1	Megascopic and microscopic identification of sedimentary rocks	20	
	2	Megascopic identification of invertebrate fossils	10	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4				✓
CO 5		✓		✓
CO 6	✓			✓

References:

1. Boggs, S., 2016. Principles of Sedimentology and Stratigraphy. Pearson Education. 568p.
2. Prothero, D.R., Schwab, F., 2013. Sedimentary Geology. W.H. Freeman, 593 p
3. Henry Woods: Invertebrate palaeontolgy – Cambridge.
4. Raup, D.M. and Stanely, M.S.: Principles of Palaeontology, CBS Publishers.
5. Moore , R.C., Laliker , C.G.&Fishcher, A.G.: Invertebrate Fossils , Harper brothers
6. Shrock. R.R. and Twenhofel , W.H – 1953: Principles of invertebrate Palaeontology, Amold publication

Semester V

Programme	B. Sc. Geology				
Course Code	GEL5CJ301				
Course Title	**GEOINFORMATICS & FIELD GEOLOGY - II**				
Type of Course	Major				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	GEL4CJ203 Field Geology -I				
Course Summary	Field Geology - II is a hands-on course designed to provide undergraduate students with practical experience in geological fieldwork. Through field trips, mapping exercises, and data collection activities, students will learn essential field techniques, geological mapping skills, and interpretation of geological features and structures.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate proficiency in field techniques for geological mapping and data collection.	U	F	Exam
CO2	Identify and describe geological formations, rock types, and structural features in the field.	Ap	C	Quiz
CO3	Apply principles of geoinformatics for geological mapping	An	P	Assignment
CO4	Evaluate the geological features of a terrain using published geological maps	E	M	Practical Assignment
CO5	Collaborate effectively in fieldwork teams and communicate geological findings through field reports and presentations.	Ap	F	Assignment
CO6	Develop critical thinking and problem-solving skills through hands-on field experiences.	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: GEOINFORMATICS & FIELD GEOLOGY - II

Module	Unit	Content	Hrs	Marks
I		**Geological Mapping**	**12**	**12**
	1	Use of aerial photographs and satellite imagery in geological mapping	3	
	2	Integration of field observations with geospatial data	3	
	3	Interpretation of geological structures using Google Earth data	3	
	4	Introduction to mobile applications (App) in Field Geology	3	
II		**Rock identification in the field**	**8**	**12**
	5	Identification and classification of igneous and metamorphic rocks	3	
	6	Petrographic analysis of igneous and metamorphic textures	3	
	7	Charateristic features of igneous and metamorphic terrains	3	
	8	Case study of structural features in any one terrain	3	
III		**Types of Remote Sensing & Digital Image Processing**	**10**	**20**
	9	Optical remote sensing – panchromatic, multispectral, superspectral & hyperspectral	2	
	10	Thermal remote sensing: principles and applications	2	
	11	Microwave remote sensing : Active & Passive	2	
	12	Radars: Synthetic Aperture Radar & Real Aperture Radar	2	
	13	Introduction to digital image processing	2	
	14	Preprocessing – Geometric and radiometric corrections		
		Image registration, enhancement & filtering		
		Image classification: Supervised & Unsupervised		
IV		**GIS Operations**	**19**	**26**
	14	DBMS & Data management in GIS	2	
	15	Topology and spatial relationships- adjacency, containment, connectivity	2	
	16	Database query	2	
	17	Geospatial measurement	2	
	18	Overlay operations	2	
	19	Network analysis	2	
	20	Surface analysis	2	
	21	Introduction to Bhukosh Portal of Geological survey of India	2	
	22	Analysis of the Geological details from any one map downloaded from Bhukosh portal	3	
V		**Practical**	**30**	**10**
	The practical component of this course will be carried out as a fieldwork programme covering various geological formations across India. The actual days of field work should be 6 to 7 days excluding travel period.			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ Mid semester Exam	5	Mark for practical work will be awarded based on students' performance in the fieldwork.
2	Seminar/ Viva/ Quiz	3	
3	Assignment	2	

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Basic Geological Mapping. Richard J. Lisle, Peter Brabham, and John W. Barnes (2011), Wiley-Blackwell. ISBN: 978-0470686345

2. Geological Field Techniques. Tom McCann (2012). Springer. ISBN: 978-9400739156

3. Field Geology Illustrated. Terry S. Maley (1994), Mineral Land Publications ISBN: 978-0962517130
4. Geology in the Field. Robert R. Compton (1985) John Wiley & Sons, ISBN: 978-0471842245

5. Field Geology. Frederic H. Lahee (1961) McGraw-Hill, ISBN: 978-0070355918.

Programme	B. Sc. Geology				
Course Code	GEL5CJ302				
Course Title	**IGNEOUS PETROLOGY**				
Type of Course	Major				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	2	75
Pre-requisites	NIL				
Course Summary	Igneous Petrology is an undergraduate-level course that focuses on the study of the origin, composition, textures, and classification of igneous rocks.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the composition and constitution of magmas, including primary and parental magmas.	U	F	Exam
CO2	Identify and describe the various forms of intrusive and extrusive igneous rocks.	An	C	Quiz
CO3	Analyze the textures of igneous rocks and interpret their petrogenetic significance.	An	P	Assignment
CO4	Classify igneous rocks based on genetic, chemical, and mineralogical criteria.	C	P	Viva
CO5	Explain the processes of crystallization and magmatic differentiation in the formation of igneous rocks.	Ap	P	Assignment
CO6	Evaluate the petrographic characteristics and origin of specific igneous rock types.	C	P	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: IGNEOUS PETROLOGY

Module	Unit	Content	Hrs	Marks
I		**Introduction to Igneous Petrolog**	**14**	**20**
	1	Composition and constitution of magmas	2	
	2	Forms of intrusive and extrusive igneous rocks	2	
	3	Structures and textures of igneous rocks	3	
	4	Overview of classification schemes for igneous rocks	1	
	5	Genetic and chemical bases of igneous rock classification	1	
	6	Classification schemes based on color index, silica saturation, alumina saturation	2	
	7	Introduction to CIPW classification and Tyrrel's tabular classification	2	
	8	Petrogenesis of igneous rock types based on classification criteria	2	
II		**Crystallization Processes and Magmatic Differentiation**	**10**	**15**
	9	Crystallization processes in unicomponent and binary magmas - Diopside – Anorthite Eutectic system, Albite – Anorthite Solid-Solution system, Forsterite – Silica incongruent melting system	4	
	10	Bowen's reaction series and its significance	2	
	11	Magmatic differentiation: fractional crystallization, liquid immiscibility, assimilation.	2	
	12	Reaction principles and their role in igneous petrology. Consanguinity, Variation diagrams and petrographic provinces	2	
III		**Intrusive & Extrusive Igneous Rocks**	**11**	**20**
	13	Study of intrusive igneous rock types: Granite, Granodiorite, Syenite, Diorite, Gabbro	2	
	14	Petrographic characteristics and modes of occurrence of each rock type	2	
	15	Interpretation of textures and mineralogy in intrusive igneous rocks	2	
	16	Study of extrusive igneous rock types: Basalt, Andesite,Rhyolite	2	
	17	Characteristics of lava flows and pyroclastic deposits	1	
	18	Analysis of extrusive igneous rocks and interpretation of their textures	2	
IV		**Special Igneous Rocks and Petrogenesis**	**10**	**15**
	19	Petrographic characteristics and origin of special igneous rock types: Pegmatites, Lamprophyres, Alkaline rocks, Anorthosites	2	
	20	Interpretation of petrogenetic processes based on field observations and laboratory analysis	1	
	21	Significance of special igneous rocks in understanding magmatic processes	2	
	22	Significance of special igneous rocks in understanding tectonic environments	2	
V		**Practical**	**30**	**10**
		Identification of hand specimens and thin sections of important igneous rocks.	**30**	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. Frost, B.R., Frost, C.D., 2014. Essentials of Igneous and Metamorphic Petrology. Cambridge University Pres. 318 p.
2. Raymond, L.A., 2002. Petrology: The Study of Igneous, Sedimentary and MetamorphicRocks, 720p.
3. Winter, J.D., 2009. Principles of Igneous and Metamorphic Petrology. Pearson, 720 p.

Programme	B. Sc. Geology				
Course Code	GEL5CJ303				
Course Title	**METAMORPHIC PETROLOGY**				
Type of Course	Major				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites					
Course Summary	Metamorphic Petrology is an undergraduate-level course that focuses on the study of metamorphic rocks and the processes involved in their formation.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the definition and variables of metamorphism	U	F	Exam
CO2	Identify and classify different types of metamorphism based on principal agents, geological settings, and plate tectonic settings.	An	C	Quiz
CO3	Recognize and interpret metamorphic structures and textures in rocks.	An	P	Assignment
CO4	Describe equilibrium mineral assemblages, chemographic diagrams, metamorphic grades, and isograds.	C	P	Viva-Voce
CO5	Analyze metamorphic facies, paired metamorphic belts, and their relationship to plate tectonics.	Ap	P	Assignment
CO6	Interpret the petrography and origin of metamorphic rock types and understand the processes of prograde and retrograde metamorphism.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: METAMORPHIC PETROLOGY

Module	Unit	Content	Hrs	Marks (70)
I		**Introduction to Metamorphism**	**10**	**15**
	1	Metamorphism – Definition	2	
		Limits of metamorphism (low and high T/P limits and influence of water and bulk compositions on metamorphic limits).		
	2	Variables of metamorphism – temperature, lithostatic pressure, deviatoric stress, fluids.	2	
	3	Types of metamorphism – classification based on the principal agents - thermal, dynamic, dynamo-thermal, hydrothermal	2	
	4	Types of metamorphism – classification based on geological setting – contact, shock, high-strain, regional (burial, ocean-ridge, orogenic.		
	5	Types of metamorphism – classification based on based on plate tectonic setting – metamorphism at convergent, divergent, and transform plate margins.		
	6	Fault-zone and impact metamorphism.	2	
II		**Classification of Metamorphic Rocks**	**10**	**15**
	7	Classification of metamorphic rocks: foliated and lineated; non-foliated and non-lineated; specific rock groups (Quartzite, Greenstone, Amphibolite, Serpentinite, Calc-silicate, Skarn).	2	
	8	Metamorphic structures – fabric, layer, foliation, schistosity, cleavage, gneissosity, lineations.	2	
	9	Metamorphic textures – augen, cataclastic, corona, decussate, epitaxial, flaser, granoblastic, lepidoblastic, megacrystic, nematoblastic, poikiloblastic, porphyroblastic, strain shadow, symplectite, and relict textures.	2	
III		**Mineral Assemblages and Metamorphic Grade**	**9**	**20**
	10	Equilibrium mineral assemblages; Introduction to chemographic diagrams: ACF, AKF Diagrams.	2	
	11	Metamorphic grades and isograds; mineral zones and Barrowian sequence.	2	
	12	Metamorphic facies – zeolite, prehnite-pumpellyite, greenschist, epidote-amphibolite, amphibolite, granulite, blueschist, eclogite, and contact metamorphic facies.	1	
	13	Facies series and plate tectonics – paired metamorphic belts.	2	
IV		**Petrography and Origin of Metamorphic Rocks**	**19**	**20**
	14	Metamorphic effects on argillaceous (medium P-T Barrovian) rocks.	2	
	15	Metamorphic effects on calcareous (contact metamorphism) rocks.		
	16	Metamorphic effects on basic igneous (regional metamorphism) rocks.		
	17	Petrography and origin of Slate, Phyllite, Chlorite schist, Kyanite schist, Biotite schist	1	
	18	Petrography and origin of Biotite gneiss, Hornblende gneiss, Amphibolite		
	19	Petrography and origin of Charnockite, Eclogite, and Mylonite.		
	20	Prograde and retrograde metamorphism.	2	

	21	Nature of metamorphic fluids and metasomatism.		
	22	Anatexis and migmatites; metamorphic differentiation.		
V	**Open Ended Module**		**12**	**10**
		Identify various metamorphic rocks from different settings in hand specimens and thin sections, and understand their origin with respect to the processes.	**12**	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz/	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		
CO 5		✓		✓
CO 6		✓	✓	✓

References:

1. Barker, A.J., 1990. *Introduction to Metamorphic Textures and Microstructures.* Blackie, 162p.
2. Bucher, K. and Grapes, R., 2011. *Petrogenesis of Metamorphic Rocks*. Springer-Verlag, Berlin-Heidelberg, 428p.
3. Frost, C.D., Frost, B.R, 2013. *Essentials of Igneous and Metamorphic Petrology,* Cambridge University Press, 336p.
4. Kornprobst, J., 2012. *Metamorphic Rocks and Their Geodynamic Significance: A Petrological Handbook,* Springer, 206p.
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6. Miyashiro, A., 1978. Metamorphism and Metamorphic Belts. 3rd Edition. George Allen & Unwin, London, 492p.
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8. Spear, F.S. 1995. *Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths.* Monograph, Mineralogical Society of America, 799p.
9. Vernon, R.H. and Clarke, G.L., 2008. *Principles of Metamorphic Petrology.* Cambridge University Press, 446p.
10. Winter, J.D., 2011. *Principles of Igneous and Metamorphic Petrology*, Prentice-Hall, 728p.

Semester VI

Programme	B. Sc. Geology				
Course Code	GEL6CJ304				
Course Title	**ECONOMIC GEOLOGY**				
Type of Course	Major				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	The course provides a detailed account of the processes of ore formation and also the various economic mineral deposits and fossil fuel reserves available in India.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the historical development of economic geology and the geochemical distribution of elements.	U	F	Exam
CO2	Identify the materials of mineral deposits, including ore and gangue minerals	Ap	C	Quiz / Viva
CO3	Classify mineral deposits according to Lindgren's and Bateman's classification	Ap	P	Assignment
CO4	Analyze the controls of ore localization	E	M	Viva
CO5	Evaluate the various processes of ore formation, and their resulting mineral deposits.	Ap	F	Assignment
CO6	Explain the ore deposits and fossil fuels resources of India with reference to their geologic settings	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: ECONOMIC GEOLOGY

Module	Unit	Content	Hrs	Marks
I		**Introduction to Economic Geology**	**4**	**10**
	1	Historical development of economic Geology. Geochemical distribution of elements.		
	2	Materials of mineral deposits – ore minerals, gangue minerals, tenor and grade of ores, ore shoots and bonanzas.		
	3	Brief study of metallogenic epochs and provinces – geologic thermometers.		
	4	Classification of mineral deposits. Outline of Lindgren's and Bateman's classification- Syngenetic and epigenetic deposits.		
	5	Controls of ore localization – structural, stratigraphic, physical and chemical.		
II		**Magmatic Processes of Ore Formation**	**4**	**10**
	6	Magmatic processes – mode of formation		
	7	Early magmatic processes and deposits, disseminations, segregations and injections		
	8	Late magmatic processes and deposits – Residual liquid segregation and injection		
	9	Immiscible liquid segregation and injection – sublimation.		
III		**Metamorphic, Hydrothermal & Sedimentary Processes**	**22**	**30**
	10	Metamorphic processes – Formation of Graphite, Asbestos, Talc, Soapstone and Sillimanite group of minerals		
	11	Contact Metasomatic processes – the process and effects – resulting mineral deposits.		
	12	Hydrothermal processes – principles – Factors affecting deposition – wall rock alteration – minerals sequence – cavity filling deposits Fissure veins, shear – zone, stock-work, saddle reef, ladder vein, fold cracks, breccia filling, solution cavities, pore space and vesicular filling		
	13	Replacement deposits- process and deposits – criteria of replacement.		
	14	Oxidation and supergene sulphide enrichment – solution and deposition in the zone of oxidation – secondary sulphide enrichment – Gossans and capping		
	13	Sedimentary processes and cycles – principles involved in sedimentation – cycles of Iron and manganese		
	14	Weathering processes – principles- Residual concentration process and deposits		
	15	Mechanical concentration principles – eluvial, alluvial, beach and eolian placers.		
IV		**Ore Deposits & Fossil Fuels Resources of India**	**15**	**20**
	16	Occurrence and distribution in India of metalliferous deposits - base metals, iron, manganese, aluminium, chromium		
	17	Occurrence and distribution in India of metalliferous deposits - nickel, gold, silver, molybdenum.		
	18	Indian deposits of non-metals – Diamond, mica, asbestos, barytes, gypsum, graphite, apatite and beryl.		
	19	Indian deposits of non-metals – Gemstones, refractory minerals,		

		abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries.		
	20	Coal and its properties: Different varieties and ranks of coal. Origin of coal. Geology and coal petrography of different coalfields of India.		
	21	Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps.		
	22	Geographical and geological distributions of onshore and offshore petroliferous basins of India.		
V		**Practical**	**30**	**10**
		Identification of economic mineral deposits. Understanding the spatial distribution of Indian mineral deposits using spatial data and software.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Pohl, W.L., 2016. Economic Geology Principles and Practice. Wiley-Blackwell, 678 p.

2. Sarkar, S.C., Gupta, A., 2012. Crustal Evolution and Metallogeny in India.

CambridgeUniversity Press, 912 p

Programme	B. Sc. Geology				
Course Code	GEL6CJ305				
Course Title	**STRUCTURAL GEOLOGY & GEOTECTONICS**				
Type of Course	Major				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Field Geology – I & Field Geology –II (Desirable)				
Course Summary	The course in structural geology & geotectonics is a theoretical introduction to these two branches of geology.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The student will understand the fundamental structural geology concepts	U	F	Exam
CO2	The student will be able to apply the fundamental field techniques of structural geology	Ap	C	Quiz
CO3	The student will be able to discuss rock deformation	An	P	Assignment
CO4	The student will be able to discuss various structural features such as folds, faults and joints	E	M	Viva
CO5	The student will be able to explain the structure and characteristic of layers of the Earth	Ap	F	Assignment
CO6	The student will be able to describe the concept of plate tectonics and the features associated with it	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: STRUCTURAL GEOLOGY & GEOTECTONICS

Module	Unit	Content	Hrs	Marks
I		**Introduction to Structural Geology & Rock Deformation**	**10**	**15**
	1	Introduction to Structural Geology, Diastrophic and non-diastrophic structures.	2	
	2	Effects of topography on structural features. Rules of 'V'	2	
	3	Rock deformation - stress and strain, types of stress - type of strain - stress-strain diagram.	2	
	4	Stages of deformation, mechanism of elastic, plastic, and brittle deformation.	2	
	5	Introduction to equal area and stereographic projections	2	
II		**Structural elements**	**15**	**20**
	6	Folds: Elements of folded surface	2	
	7	Classification of folds - descriptive study of different types of folds -	2	
	8	Introduction to the mechanics of folding; Buckling, Bending, Flexural slip and flow folding	2	
	9	Fault: Classification and description of Faults.	3	
	10	Joints: Definition, classification, descriptive study, and geological significance of joints.	2	
	11	Lineation, Foliation and their types.	2	
	12	Unconformities: Definition, types and significance. Recognition of Unconformities in the field and on maps	2	
III		**Layers of Earth**	**10**	**15**
	13	Structure and characteristics of layers of the Earth: Crust (Continental and Oceanic), Mantle (Lower and Upper), Core (Inner and Outer);	2	
	14	Geophysical and petrochemical characteristics of Lithosphere and Asthenosphere	3	
	15	Mantle petrology and chemical composition; Models of mantle convection	2	
	16	Mantle plumes; Hot spots	2	
	17	Super swells	3	
IV		**Plate Tectonics**	**10**	**20**
	18	Continental Drift;	2	
	19	Seafloor spreading; Palaeomagnetism	2	
	20	Plate tectonics: Basic concepts and definition. Types of plate margins.	2	
	21	Features associated with divergent, convergent, and transform plate margins.	2	
	22	Triple junctions, Benioff zones, Island arcs, rift valleys, transform faults	2	
		Practical	**30**	**10**
		Structural contouring, Thickness and depth problems and 3-point problems of dip and strike. Interpretation of structure, stratigraphy and geologic history from maps. Drawing profile sections and interpretation of geological maps of different complexities. Relation between true dip and apparent dip - width of outcrops; true thickness and vertical thickness and their mutual relation.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-						
CO 2	2	3	-	-	-	-						
CO 3	-	-	1	-	-	-						
CO 4	-	-	2	3	-	-						
CO 5	-	1	-	-	-	-						
CO 6	-	-	-	3	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Frisch, W., Meschede, M., and Blakey, R., 2011. *Plate Tectonics – Continental Drift andMountain Building*, Springer-Verlag, Berlin Heidelberg, 212p.
2. Kondie, K.C., 2011. *Earth as an Evolving Planetary System*, Academic Press, Oxford, UK,574p.
3. Turcotte, D.L. and Schubert, G., 2014. *Geodynamics*, Cambridge University Press, 636p.
4. Twiss, R.J., Moores, E.M., 2007. Structural Geology. W.H. Freeman, 500p.

Programme	B. Sc. Geology				
Course Code	GEL6CJ306				
Course Title	**INDIAN GEOLOGY**				
Type of Course	Major				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	The course introduces the different stratigraphic units of India with particular reference to their formation, lithology and other relevant details.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will demonstrate knowledge of the early Precambrian stratigraphy of India	U	F	Exam
CO2	Students will be able to identify and describe the late Precambrian stratigraphy of India	Ap	C	Quiz
CO3	Students will gain an understanding of the distribution, characteristics, and economic importance of Paleozoic rocks in India,	An	P	Assignment
CO4	Students will comprehend the depositional environments, distribution, life, classification, and economic significance of Mesozoic formations in India	E	M	Viva
CO5	Students will gain insight into the geological events that occurred during the Cenozoic era in India	Ap	F	Assignment
CO6	Students will analyze and interpret geological processes and events throughout geological history of the subcontinent.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: INDIAN GEOLOGY

Module	Unit	Content	Hrs	Marks
I	**Precambrian Stratigraphy**		**12**	**20**
	1	Sargur supracrustals.		
	2	Granulite blocks of southern India		
	3	Dharwar Supergroup.Aravalli Supergroup		
	4	Delhi Supergroup, Cudappah Supergroup, Vindhyan Super group.		
	5	Brief study of Singhbhum craton, Sausar and Sakoli group		
II	**Paleozoic Stratigraphy**		**12**	**15**
	6	Cambrian of Salt Range. Age of Saline Series		
	7	Upper Carboniferous and Permian rocks of Salt Range		
	8	Paleozoic rocks of Kashmir Valley		
	9	Paleozoic rocks of Spiti Valley		
	10	Paleozoic rocks of Peninsular India		
III	**Mesozoic Stratigraphy**		**12**	**20**
	11	The Depositional Environment–distribution-life-classification and economic importance of Gondwana formations of India		
	12	Coastal Gondwana of India, Gondwana formations of Tamil Nadu		
	13	Triassic of Spiti – The Lilang System, Jurassic of Kutch		
	14	Cretaceous of Tiruchirapalli – Pondicherry – Bagh Beds		
	15	Deccan traps: distribution, structure, Lameta beds – infratrapean and intertrappean beds, age of the Deccan traps		
IV	**Cenozoic Stratigraphy**		**12**	**15**
	16	Comprehensive account of the geological events took place during Cenozoic Era in India		
	17	Rise of Himalayas, stratigraphy of Siwalik system, fauna and flora of Siwaliks		
	18	Tertiary rocks of Assam, Karewa formation, Tertiary rocks of Tamil Nadu, Tertiary rocks of Kerala		
	19	Pleistocene Glaciation. Cenozoic oil bearing formations of India		
V	**Open – Ended Module**		**12**	**10**
		Discuss the new finding in Indian Geology with reference the research papers published in this area. Identify the spatial distribution of various geological units with reference to the map of India.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar	End Semester Examinations
CO 1			✓
CO 2	✓		
CO 3	✓		
CO 4		✓	✓
CO 5			
CO 6			✓

References:

1. Sharma, R.S., 2009. *Cratons and Fold Belts of India*. Springer.
2. Krishnan M.S. (2003)- Geology of India and Burma, 6th Edition, CBS.
3. Wadia D.N. (1953) – Geology of India, TATA McGraw – Hill.
4. Pascoe, E.H.(1968) - A manual of the Geology India and Burma, Govt of India Publications.
5. Vaidyanathan & Ramakrishnan . (2008) - GSI publications, Bangalore. Geology of India Vol 1 &2.

Semester VII

Programme	B. Sc. Geology				
Course Code	GEL7CJ401				
Course Title	**HYDROGEOLOGY**				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	This course introduces students to the principles of hydrogeology, focusing on the study of groundwater flow, aquifer properties, groundwater exploration, and water quality. Topics include hydrological cycle, aquifer characterization, groundwater flow equations, well hydraulics, saline water intrusion and groundwater exploration.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts of hydrogeology and the hydrological cycle.	U	F	Exam
CO2	Analyse aquifer properties and their significance in groundwater flow.	Ap	C	Quiz
CO3	Apply groundwater flow equations to solve problems related to flow dynamics.	An	P	Assignment
CO4	Demonstrate proficiency in well hydraulics and aquifer testing techniques.	E	M	Viva
CO5	Explain methods for groundwater exploration and management.	Ap	F	Assignment
CO6	Evaluate the sources and remediation of saline water intrusion into groundwater.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: HYDROGEOLOGY

Module	Unit	Content	Hrs	Marks
I	1	Origin of water: meteroic, juvenile, magmatic and sea waters.	8	15
	2	Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs.		
	3	Subsurface movement and vertical distribution of groundwater. Springs.		
	4	Classification of aquifers. Concepts of drainage basin and groundwater basin.		
	5	Hydrological properties of rocks.		
	6	Determination of permeability in laboratory and in field.		
	7	Water table fluctuations – causative factors, concept of barometric and tidal efficiencies.		
II	8	Theory of groundwater flow. Forces causing ground water movements.	15	20
	9	Darcy's Law and its applications.		
	10	Unconfined, confined, steady, unsteady and radial flow conditions.		
	11	Pump tests – methods, data analysis and interpretation for hydrogeologic boundaries.		
	12	Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods.		
III	13	Groundwater quality – physical and chemical properties of water.	10	15
	14	Quality criteria for different uses - domestic, irrigation and industrial.		
	15	Graphical presentation of water quality data - Stiff diagram, Pie diagram, Piper's trilinear diagram and USSL diagram.		
	16	Problems of arsenic and fluoride in groundwater.		
	17	Saline water intrusion in coastal and other aquifers.		
	18	Ghyben-Herzberg relation. Prevention and control of saline water intrusion.		
	19	Radioisotopes in hydrogeological studies.		
IV	20	Ground water exploration -Geologic and hydrogeologic methods.	12	20
	21	Surface geophysical methods –electrical resistivity method: Wenner and Schlumberger configurations for vertical electrical sounding.		
	22	Subsurface geophysical methods – well logging for delineation of aquifers.		
	23	Remote sensing for groundwater exploration		
	24	Types of wells, drilling methods, construction, design, development and maintenance of wells		
	26	Specific capacity and its determination.		
	27	Groundwater problems related to foundation work, mining, canals and tunnels.		
	28	Problems of over exploitation and groundwater mining.		
	29	Groundwater development in urban areas and rain water harvesting, Artificial recharge methods.		
	30	Groundwater provinces of India.		
V		**Practical**	**30**	**20**
		Practical problems related to various aspects of the subject		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Bouwer,H Groundwater Hydrology. 1978
2. Davies and De Wiest, Hydrogeology, John Wiley and Sons, 1966
3. Dominico, P. A.. Concepts and models in Groundwater Hydrogeology, McGrawHill
4. Fletcher, G. Driscoll, Groundwater and wells, Science Publ., Jodhpur, 1986
5. Karanth, K. R., Groundwatcr and wells, Science Publ., Jodhpur, 1986
6. Linsley, R. K., Jkohler, M. A., and Paulhus, J. L. H., Applied Hydrology, Tata McGrawHill, 1975
7. Raghunath, H. M., Groundwater, Wiley Eastern, 1987
8. Todd, D. K., Groundwater Hydrology, John Wiley and Sons, 1980
9. Tolman, C. F., Groundwater, McGraw Hill
10. Walton, W. C, Groundwater Resource Evaluation, McGraw Hill, 1970
11. Freeze and Cherry – Groundwater

Programme	B. Sc. Geology				
Course Code	GEL7CJ402				
Course Title	**APPLIED GEOMORPHOLOGY**				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	This course introduces students to the fundamental principles and applications of geomorphology in understanding landscape evolution, landform processes, and environmental changes.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the theoretical foundations of geomorphology and its relevance to geological processes.	U	F	Exam
CO2	Identify and analyze landforms and geomorphic processes using field-based and remote sensing techniques.	Ap	C	Quiz
CO3	Evaluate the impact of human activities on landscape evolution and geomorphic processes.	An	P	Assignment
CO4	Apply geomorphological concepts and methods to solve real-world environmental problems and land management issues.	E	M	Viva
CO5	Communicate effectively about geomorphic features, processes, and their significance in both written and oral formats	Ap	F	Assignment
CO6	Understand the theoretical foundations of geomorphology and its relevance to geological processes.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: APPLIED GEOMORPHOLOGY

Module	Unit	Content	Hrs	Marks
I	**Introduction to Geomorphology**		8	15
	1	Geomorphic principles and processes..		
	2	Theory of uniformitarianism.		
	3	Control of geomorphological features by geologic structures, lithology, climate and time		
	4	Geomorphologic cycles. Models of landscape evolution.		
II	**Fluvial & Coastal Geomorphology**		12	20
	5	Streams-stream hydraulics		
	6	Drainage basin, Morphometric analysis of drainage basins.		
	7	Fluvial-denudational and erosional landforms		
	8	Concept of rejuvenation and interruptions in the evolution of land.		
	9	Coastal Geomorphology. Landforms of wave erosion and deposition.		
	10	Beach Profiling		
	11	Desert Geomorphology – Processes of erosion and transport		
	12	Erosional and depositional features – dunes, rock varnish, pediment, inselbergs, wadis.		
III	**Geomorphology of Kerala**		12	15
	13	Wetlands- Geological significance		
	14	Wetlands - classification and mode of formation		
	15	Geomorphology of Kerala- classification, relief features, geological Significance,		
	16	Rivers of Kerala		
	17	Geomorphic features of the Indian subcontinent.		
IV	**Applications**		13	20
	18	Hill slopes- forms in relation to lithology and structural weakness in rocks;		
	19	Control and mass movement, modification by overland flow of hill slopes.		
	20	Slope stability.		
	21	Applied Geomorphology: Application of Geomorphology in Civil Engineering,		
	22	Applied Geomorphology: Application of Geomorphology in Hydrogeology, and Environmental Studies.		
	Practical		30	20
		Interpretation of toposheets and identification of geomorphic features, fluvial and coastal land forms. Calculation of surface area and slope. Study of drainage pattern and morphometric analysis.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

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8. Pethick, J., An introduction to coastal geomorphology, Arnold Heinman publishers, (India), New Delhi, 1984
9. Schumm, S .A. (Ed), Drainage Basin morphology- In Bench mark papers in Geology
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Programme	B. Sc. Geology				
Course Code	GEL7CJ403				
Course Title	**ADVANCED PALAEONTOLOGY**				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Knowledge in the fossils, processes of fossilization, uses of fossils, microfossils and evolution				
Course Summary	The course deals with the preparation, identification and application of microfossils, and the evolution of the vertebrates based on their fossil evidences, focussing on the evolution of Spices, Mesozoic reptiles, Birds, Equus, Elephus and Man				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the scope & classification of microfossils, and the techniques involved in the preparation and preservation of microfossils	U	F, P	Class tests/Quiz/ Viva
CO2	Classify the stromatilites, spores and pollens with their geological significance and applications	R	F	Class tests/Quiz/ Seminars
CO3	Discuss the application of microfossils in petroleum exploration, and in the determination of Paleoenvironments and Palaeoclimate	An	F, C	Class tests/ Viva/ Assignments
CO4	Explain the origin of life, trends & concepts of evolution, mass extinction, and the application of stable isotopes of O, C & S in the paleontological studies	U	F, C & P	Class tests/ Assignments/ Seminars
CO5	Illustrate the evolutional history of Pisces, Mesozoic reptiles, Equus, Elephus and Man	U	F&C	Class tests/ Assignments/ Seminars
CO6	Prepare the slides of microfossils of Ostracoda, Foraminifera and Bryozoa, to identify them under microscope	Ap	F&P	Lab tests

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ADVANCED PALAEONTOLOGY

Module	Unit	Content	Hrs	Marks
I		**Micropalaeontology**	**14**	**20**
	1	Techniques in collection, separation, preparation and preservation of microfossils	3	
	2	Classification, morphology, palaeoecology and stratigraphic importance of Foraminifera, Ostracoda, Bryozoa	3	
	3	Classification, morphology, palaeoecology and stratigraphic importance of Radiolaria, Diatoms & Conodonts		
	4	Palynology: Morphology, classifications, geological significance and application of spores and pollens	3	
	5	Classification of stromatolites and its stratigraphic importance.	2	
	6	Application of microfossils in the petroleum exploration		
	7	Significance of microfossils in the studies of Palaeoecology, Palaeoclimate, palaeoenvironments and Palaeotemperature	3	
II		**Origin of life, principles of evolution and mass extinction**	**9**	**15**
	8	Chemical origin of life, Miller's experiment	2	
	9	Phylogenic tree, trends and mechanism of evolution	2	
	10	Early & modern theories of organic evolution	1	
	11	Application of stable isotope studies of oxygen, carbon and sulphur in paleontology	2	
	12	Major mass extinction events in earth's history	2	
III		**Evolution of Pisces and Mesozoic reptiles**	**14**	**20**
	13	Early fishes: types, morphology – jawless, armoured & lung fishes	2	
	14	Evolution, taxonomic classification, and chronological distribution of Pisces through earth's history	2	
	15	Mesozoic reptiles: dinosaurs – bird & lizard hipped, and Carnivorous & herbivorous forms	3	
	16	Mesozoic reptiles: aquatic & marine reptiles, and flying reptiles	3	
	17	Evolution of Mesozoic birds: Anchiornis, Archaeopteryx, Confuciusornis, Hesperornis & Ichthyornis	2	
	18	Cenozoic & modern birds – Paleognaths & Neognaths	2	
IV		Evolution of Mammals	**8**	**15**
	19	Elephantidae – Stegotetrabelodon, Mammuthus, Loxodonta & Elephas	2	
	20	Evolution of horses from Hyracotherium to Equus	2	
	21	Human evolution from apes to Homo sapience	2	
	22	Siwalik vertebrates	2	
V		Practical-Micropalaeontology	**30**	**20**
	1	Prepare the slides of microfossils	10	
	2	Identification of the microfossils of Ostracoda, Foraminifera and Bryozoa under microscope	20	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6	✓			✓

References:

1. Shrock R.R., Berk Twenhofel W.H. Principles of Invertebrate Palaeontology, McGraw Hill, 1953
2. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
3. Bilal U. Haq, Anne Boersma, Introduction to Marine Micro-Palaeontology, Elsevier, 1998
4. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961

Programme	B. Sc. Geology				
Course Code	GEL7CJ404				
Course Title	**MARINE GEOLOGY**				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	75
Pre-requisites	NIL				
Course Summary	Marine Geology is a course that explores the geological processes and marine phenomena shaping the Earth's oceans and seabed. This course introduces students to the physical, chemical, geological, and biological aspects of marine environments, including the study of seafloor topography, sedimentation, marine life, and coastal processes.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the geological processes shaping marine environments.	U	F	Exam
CO2	Describe the physical characteristics of the ocean, including water properties, currents, and waves.	Ap	C	Quiz
CO3	Analyse the geological features of the seafloor, including continental margins, ocean basins, and mid-ocean ridges.	An	P	Assignment
CO4	Explain the principles of marine sedimentation and the formation of sedimentary deposits.	E	M	Viva
CO5	Discuss the role of oceans in global climate regulation and the impact of climate change on marine ecosystems.	Ap	F	Assignment
CO6	Apply knowledge of marine geology to address contemporary environmental challenges and conservation efforts.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: MARINE GEOLOGY

Module	Unit	Content	Hrs	Marks
I	1	Overview of marine geology	5	10
	2	Geological history of the oceans		
	3	Physical properties of seawater		
	4	Oceanic circulation and climate patterns		
II	5	Characteristics of the ocean floor (continental margins, abyssal plains, seamounts)	10	20
	6	Plate tectonics and marine geology		
	7	Mid-ocean ridges, hydrothermal vents, and seafloor spreading		
	8	Submarine canyons, trenches, and volcanic arcs		
III	9	Types of marine sediments (terrigenous, biogenous, hydrogenous)	8	15
	10	Processes of sedimentation and diagenesis		
	11	Formation of marine sedimentary structures (beds, layers, ripples)		
	12	Distribution patterns of marine sediments and sedimentary basins		
IV	13	Coastal geomorphology and processes (erosion, deposition, coastal landforms)	22	25
	14	Coastal hazards and management strategies		
	15	Marine ecosystems and biodiversity		
	16	Human impacts on coastal environments and marine habitats		
	17	Ocean-atmosphere interactions and climate regulation		
	18	Oceanic heat transport and global climate patterns		
	19	Impacts of climate change on marine environments - sea level rise		
	20	Impacts of climate change on marine environments- ocean acidification, coral bleaching)		
	21	Mitigation measures for addressing climate change in marine ecosystems		
	22	Adaptation strategies for addressing climate change in marine ecosystems		
		Practical	**30**	**20**
		Study of ocean circulation patterns. Ocean floor topography identification from bathymetric data.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. John, L. Mero, Oceanic Mineral resources
2. Ph, H. Kuenen, Marine Geology, John Wiley and Sons.
3. Keith S.Stowe, Ocean Science. John Wiley and Sons
4. Kenneth, J.P., Marine Geology, Prentice Hall Inc., 1982
5. Shepard, F. P., Submarine Geology, Harper and Row Publishers, New York
6. Sverdrup, H. V., et al, The Ocean
7. Trask, P. D., Recent Marine sediments, Dover publications, 1939
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10. J. P. Riley R. Chester, Chemical Oceanography, Academic Press
11. L. Pickard W. J. Emery, Descriptive Physical Oceanography, Pergamon
12. Colin D Woodroffe, Coasts: Form, Process and Evolution, Cambridge.

Programme	B. Sc. Geology				
Course Code	GEL7CJ405				
Course Title	**ADVANCED MINERALOGY & CRYSTALLOGRAPHY**				
Type of Course	Major				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	Advanced topics in Mineralogy & Crystallography				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts of crystallography, including crystal symmetry and translational periodicity.	U	F	Exam
CO2	Demonstrate proficiency in the derivation and application of crystal classes.	Ap	C	Quiz
CO3	Utilize various crystal notation systems and compare their advantages and limitations.	An	P	Assignment
CO4	Apply X-ray diffraction principles to identify minerals and calculate cell dimensions.	E	M	Viva
CO5	Analyze the optical properties of minerals under polarized light and determine their optic sign and axial angle.	Ap	F	Assignment
CO6	Describe the mineralogical composition of Earth's crust and mantle and understand mineral transformations with depth.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ADVANCED MINERALOGY & CRYSTALLOGRAPHY

Module	Unit	Content	Hrs	Marks
I	1	Crystallography-Crystalline state-Repetition theory.	7	15
	2	Translation periodicity of crystals.		
	3	Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-		
	4	symmetrical plane and symmetrical lattices.		
	5	Derivation of 32 crystal classes..		
II	6	Crystal notation- Schoenflies notation. Herman Mauguin symbols-comparison between Schoenflies and International notations.	15	20
	7	Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios.		
	8	Napier's theorem and equation of the normal.		
	9	X-ray diffraction method- basic principles. X-ray diffractometer-Powder methods		
	10	Bragg's law and its application		
	11	Calculation of cell dimensions-identification of minerals from X-ray diffraction patterns.		
	12	Stereographic projection of crystals		
III	13	Plane polarized and cross polarized light; Behaviour of isotropic and anisotropic minerals in polarized light.	15	20
	14	Double refraction; Refractive index; Birefringence; Interference colours and determination of order.		
	15	Conoscopic observations of minerals under petrological microscope		
	16	Formation of interference figures; Uniaxial and biaxial interference figures.		
	17	Determination of the Optic sign of uniaxial and biaxial minerals.		
	18	Optical indicatrices of uniaxial and biaxial minerals.		
	19	Vibration directions and sign of elongation in minerals.		
	20	Extinction and extinction angle. Determination of Optic axial angle (2V).		
IV	21	Earth mineralogy: Average mineralogical composition of crust and mantle.	8	15
	22	Mineral transformations in the mantle with depth.		
V		**Practical**	30	20
		Stereographic projection of holohedral classes of all the systems, pyritohedral, tetrahedral, plagiohcdral classes of Isometric system and Rhombohedral classes of Hexagonal system.		
		Calculations of Axial ratios, Zone symbols, Napier's rule, Laws of anharmonic ratio		
		Determination of the vibration directions of polariser and analyzer Extinction and extinction angle determination Optic sign Refractive index by Becke line method Identification of thin sections of important rock forming minerals Recalculation of mineral formula from EPMA analysis – Garnet; Pyroxene; Feldspar; biotite; hornblende		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Dyar, M.D., Gunter, M.E., 2007. *Mineralogy and Optical Mineralogy*. Min. Soc. America, 705p.
2. Demange, M., 2012. *Mineralogy for Petrologists: Optics, Chemistry, and Occurrence of Rock Forming Minerals*. CRC Press (Taylor & Francis Group), 182 p.
3. Nesse, W.D., 2012. *Introduction to Optical Mineralogy*. Oxford University Press; 4 edition, 384p.
4. Pichler, H., Riegraf, C.S., 2011. *Rock-forming Minerals in Thin Section*. Springer, 220 p.
5. Deer, W.A., Howie, R.A., Zussman, J., 2013. *Introduction to the Rock-forming Minerals*. Mineralogical Society of Great Britain & Ireland, 510 p.

Semester VIII

Programme	B. Sc. Geology				
Course Code	GEL8CJ406				
Course Title	**GEOINFORMATICS APPLICATIONS**				
Type of Course	Major				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary	Geoinformatics Applications course offers students a comprehensive understanding of the principles, techniques, and applications of geoinformatics in geology and allied sciences. By the end of the course, students will have acquired a strong foundation in geoinformatics and developed practical skills that are highly relevant in the fields of geology and allied sciences.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts and principles of Geoinformatics and its applications in Geology.	U	F	Exam
CO2	Acquire knowledge of spatial data types, Geographic Information Systems (GIS), and Remote Sensing technologies.	Ap	C	Quiz
CO3	Gain practical skills in geospatial data acquisition, processing and integration.	An	P	Practical assignment
CO4	Develop proficiency in spatial analysis techniques, including interpolation, network analysis, and spatial statistics.	E	M	Practical assignment
CO5	Apply Geoinformatics tools and techniques in geological mapping, environmental assessment, natural hazard management, and urban planning.	Ap	F	Practical assignment
CO6	Present and communicate Geoinformatics projects effectively through case studies and project presentations.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOINFORMATICS APPLICATIONS

Module	Unit	Content	Hrs	Marks
I	1	Overview of Geoinformatics	10	15
	2	Role of Geoinformatics in Geology and Environmental Sciences		
	3	Spatial Data Types: Vector and Raster		
	4	Geographic Information Systems (GIS): Concepts and Applications		
	5	Remote Sensing Technologies and Applications		
II	6	Principles of Geospatial Data Acquisition: GPS, Remote Sensing, Surveying	15	20
	7	Data Collection Methods: Field Surveys, Aerial Photography, Satellite Imagery		
	8	Data Preprocessing: Image Enhancement, Georeferencing, Mosaicking		
	9	Data Integration and Fusion Techniques		
	10	Quality Assessment and Validation of Geospatial Data		
III	11	Spatial Analysis Techniques: Buffering, Overlay, Spatial Joins	10	15
	12	Interpolation Methods: Inverse Distance Weighting, Kriging		
	13	Network Analysis and Routing		
	14	Spatial Statistics: Point Pattern Analysis, Spatial Autocorrelation		
	15	Geospatial Modeling: Suitability Analysis, Land Use/Land Cover Change Modeling		
IV	16	Geological Mapping	10	20
	17	Hydrogeological Applications		
	18	Natural Hazard Mapping and Risk Assessment		
	19	Urban Planning		
	20	Land Use Management		
	21	Mineral Exploration		
	22	Climate change analysis		
V		**Practical**	**30**	**20**
		Hands on practical using GIS & Image processing software to learn and experience various applications		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Avery, T.E. Interpretation of aerial photographs, Burges Publishing Co 1968
2. Estes, J.W. and Leslie W. Senger, Remote Sensing - Techniques for Environmental analysis, Hamilton Publishing Co., 1974
3. Ravi P Gupta Remote sensing geology, ,2nd edition , Springer, 2003
4. Thomas M. Lilesand, and Ralph W. Keiferr. Remote Sensing and Image Interpretation, John Wiley and Sons 1979
5. Shiv N Pandey, Principles and Applications of Photogeology, New age International Publishers, 2007
6. John R Jesnsen, Remote sensing of the environment, University of Carolina, Pearson Educations
7. Avery, T.E. Interpretation of aerial photographs, Burges Publishing Co 1968
8. Burrow, P. A. and Mc Donnel, R. A. Principles of Geographic Information Systems, Oxford Publishers, 1998
9. Clark, K.C. Getting started with Geographic Information System, Prentice Hall,1990
10. Demer**,** M.N. Fundamentals of GIS, John Wiley & Sons, 2000.
11. Peter A. Burrough and Ruchael, A. McDonnell, Principles of Geographical Information System, Oxford Publishers.

Programme	B. Sc. Geology				
Course Code	GEL8CJ407				
Course Title	**ENGINEERING GEOLOGY**				
Type of Course	Major				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	NIL				
Course Summary	Engineering Geology is a branch of applied science that deals with the study of geological principles and their application to engineering practices. This course aims to provide students with a comprehensive understanding of geological processes, materials, and hazards relevant to civil engineering projects.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental principles of geological processes and materials relevant to engineering applications.	U	F	Exam
CO2	Demonstrate proficiency in site investigation techniques, including geological mapping, geophysical exploration, and laboratory testing.	Ap	C	Quiz
CO3	Evaluate geological hazards such as landslides, earthquakes, and subsidence	An	P	Assignment
CO4	Apply geotechnical engineering principles to analyze and design foundations, slopes, and earthworks.	E	M	Viva
CO5	Demonstrate critical thinking skills through the analysis of case studies and research papers in engineering geology.	Ap	F	Assignment
CO6	Communicate effectively, about geological aspects of engineering projects and their implications for design and construction.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ENGINEERING GEOLOGY

Module	Unit	Content	Hrs	Marks
I	1	Definition and scope of Engineering Geology	8	10
	2	Importance of Engineering Geology in civil engineering projects		
	3	Geological time scale and rock cycle		
	4	Basic concepts of mineralogy and petrology		
II	5	Weathering processes and their effects on rocks and soils	8	10
	6	Types and classification of rocks and minerals		
	7	Soil formation and properties		
	8	Engineering properties of rocks and soils		
III	9	Methods of geological mapping and surveying	16	25
	10	Geophysical methods for subsurface exploration		
	11	Borehole drilling and sampling techniques		
	12	Laboratory testing of rock and soil samples		
	13	Landslides: causes, types, and mitigation measures		
	14	Earthquakes: seismic hazards assessment and engineering solutions		
IV	15	Subsidence and ground settlement	16	25
	16	Assessment and management of geological hazards in engineering projects		
	17	Foundation engineering principles		
	18	Slope stability analysis and design		
	19	Earthworks and soil compaction techniques		
	20	Ground improvement methods		
	21	Analysis of case studies involving geological considerations in engineering projects		
	22	Analysis of case studies involving landslides, subsidence & soil piping		
V		**Open Ended Module**	12	10
		Field visits to construction sites and geological hazard-prone areas		
		Group projects on site investigation and geological hazard assessment		
		Presentation and discussion of research papers on recent developments in engineering geology		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar	End Semester Examinations
CO 1			✓
CO 2	✓		
CO 3	✓		
CO 4		✓	✓
CO 5			
CO 6			✓

References:

1. Compton, R. R., Manual of Field Geology, John Wiley
2. Reedman, J. K, Techniques in Mineral Exploration, Allied Scientific Publishers
3. Arogyaswamy, R. N. F., Courses in Mining Geology, Oxford and IBH Pub. Co.
4. Fox, Engineering Geology
5. Peters, W. C, Exploration and Mining Geology, John Wiley
6. Bell, F.G. Fundamentals of Engineering Geology, Butterworths, 1983
7. Krynine and Judd, Principle of Engineering Geology and Geotectonic, McGraw Hill. 1957
8. Rose, A. W., Hawkes, H. F., and Webb, J. S., Geochemistry in Mineral Exploration, Academic Press
9. Gokhale, K.V.G.K. Principles of Engineering Geology B.S. Publications, 2006.

Programme	B. Sc. Geology				
Course Code	GEL8CJ408				
Course Title	**EXPLORATION GEOLOGY**				
Type of Course	Major				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	NIL				
Course Summary	Exploration Geology is a foundational course that introduces undergraduate students to the principles, methods, and techniques used in the exploration for mineral and energy resources. Students will learn about the geological processes governing the formation of mineral deposits, exploration strategies, data interpretation, and the role of geology in resource discovery.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the geological processes and controls governing the formation of mineral resources.	U	F	Exam
CO2	Identify different types of mineral deposits and their associated geological characteristics.	Ap	C	Quiz
CO3	Apply geological mapping techniques and exploration methods to assess exploration targets.	An	P	Assignment
CO4	Interpret geological, geophysical, and geochemical data to delineate prospective areas for exploration.	E	M	Viva
CO5	Evaluate the economic potential and risk factors associated with exploration projects.	Ap	F	Assignment
CO6	Communicate exploration findings effectively through written reports, presentations, and technical documents.	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: EXPLORATION GEOLOGY

Module	Unit	Content	Hrs	Marks
I	1	Overview of exploration geology and its significance in resource discovery	8	15
	2	Geological controls on mineral and energy deposits		
	3	Methods of surface and subsurface exploration. Prospecting for economic minerals.		
	4	Drilling and its types. Different methods of sampling and assaying.		
	5	Methods of ore reserve estimation.		
II	9	Geochemical exploration techniques. Mobility of elements, pathfinder elements, threshold values and geochemical anomalies.	12	15
	10	Mode of occurrence of trace elements. Primary dispersion pattern of deep-seated origin. Diffusion and leakage anomalies.		
	11	Geochemical surveys, principles and methods of sampling. Anomalies in ground and surface waters and sediments.		
	12	Biochemical anomalies. Geobotanical survey techniques. Geobotanical indicators.		
III	13	Geophysical exploration - Principles, scope, chief methods and their application.	14	20
	14	Electrical methods - principles, instruments used. Self-potential methods, resistivity methods. Application in ground water exploration.		
	15	Gravity methods - Density and rock types, correlation of gravity data, regional and local anomalies. Sample interpretation, instrument used - gravimeter.		
	16	Magnetic methods - field procedure, magnetometer, interpretation of magnetic data, correlations and applications. Principles of air borne survey.		
IV	17	Seismic method- Seismic waves, travel velocity in various geological formations – Principles Field operations.	14	20
	18	Refraction and reflection survey - correction of seismic data - methods if interpretation -determination of attitude and depth of formation.		
	19	Various types of shooting. Seismic instruments and records.		
	20	Radiometric methods principles of radioactivity, methods, types of counters: G.M. counters and Scintilometers. Field methods and interpretations.		
	21	Geophysical well logging Electrical, radiometric, sonic and thermal logging of boreholes.		
	22	Introduction to remote sensing technologies (satellite imagery, LiDAR, hyperspectral imaging)		
V	**Open Ended Module**		12	10
		Field trips to exploration sites. Case studies of important explorations		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar	End Semester Examinations
CO 1			✓
CO 2	✓		
CO 3	✓		
CO 4		✓	✓
CO 5			
CO 6			✓

References:

1. Compton.R.R., Manual of Field Geology, John Wiley
2. Dobrin M.B, Introduction to Geophysical Prospecting, Pergamon Press
3. Elements of Prospecting and Exploration, Kalyan Publishers
4. Ginzburg, I., Principles ofGeochefnical prospecting, Pergamon Press
5. Griflithis, D. and Kind, R. F., Applied Geophysics for Geologists and Engineers, Pergamon Press
6. Kovalarkim, Biochemical exploration for mineral deposits Co-Xinian Press
7. Lahee, F. H., Field Geology, Mc Graw Hill
8. Low, G.W., Geological Field Methods, Harper and brothers
9. Malyyuga,D.F.,Biochemical methods of prospecting, Consultants Bureau,NewYork
10. Reedman, J. H., Techniques in Mineral Exploration, Allied Scientific Publishers
11. Sinha, R. K.., and Sharma, N. L, Mineral Economics, Oxford and I.B.H. – Publishers
12. Swapan Haldar, Mineral Exploration, Principles and Applications, Elsevier.
13. S.M. Gandhi, B.C. Sarkar, Essentials of Mineral Exploration and Evaluation, Elsevier.

Minor Courses – Group 1

Programme	B. Sc. Geology				
Course Code	GEL1MN101				
Course Title	**GEOINFORMATICS - I**				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary					

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will acquire knowledge of the key sciences and technologies involved in geoinformatics	U	F	Exam
CO2	Students will learn about the origin and development of GIS, its components and its core functions	Ap	C	Quiz
CO3	Students will understand the advantages and limitations of different GIS platforms	An	P	Assignment
CO4	Students will understand the principles and techniques of map-making, and map projection types	E	M	Viva
CO5	Students will grasp the fundamental concepts of remote sensing	Ap	F	Assignment
CO6	Students will be able to define and explain the meaning and scope of geoinformatics, and understand its importance in various fields	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOINFORMATICS - I

Module	Unit	Content	Hrs	Marks
I	**Introduction to GIS**		**15**	**20**
	1	Meaning and scope of Geoinformatics		
	2	Sciences and technologies involved – Remote Sensing, GIS, Cartography, Photogrammetry		
	3	Origin of GIS		
	4	GIS – definition		
	5	Components – hardware, software, people, methods, data		
	6	Functions – data input and output, visualization, editing, analysis, map design		
	7	Desktop GIS, mobile GIS, web GIS		
	8	Limitations of GIS		
II	**Maps**		**10**	**15**
	9	Maps – to convey location and extent, characteristics, and spatial relationships		
	10	Classification of maps – topographic maps, thematic maps, cadastral maps		
	11	Elements of a map		
	12	Classification of projection – Cylindrical, Conical, Azimuthal		
	13	Map design		
III	**Introduction to Remote Sensing**		**10**	**15**
	14	History of Remote Sensing		
	15	Introduction to aerial photography: overlaps, flight lines, drift, crab, tilt, dead ground		
	16	Geometry of aerial photographs - scale, principal point, perspective centre, fiducial marks, nadir, focal length, airbase, photo base, isocentre, relief displacement.		
	17	Vertical & oblique aerial photographs		
	18	Visual image interpretation & elements of interpretation - tone, texture, shape, association, pattern, shadow, size		
	19	Stereoscopy - Pocket Stereoscope, Mirror Stereoscope, Parallax Bar		
IV	**Concept of Remote Sensing**		**10**	**20**
	20	Stages in Remote Sensing		
	21	Energy Source – EMR, characteristic of EMR –wave nature and particle nature. EMR spectrum		
	22	Blackbody radiation, Stefan Boltzmann's law, Wein's displacement law		
	23	Interaction of EMR with atmosphere – reflection, scattering, absorption		
	24	Interaction of EMR with earth's surface features – reflection, transmission		
	25	Spectral Reflectance of land cover – Vegetation, Soil, Water		
V	**Practicals**		**30**	**10**
	1	Interpretation of aerial photographs		
	2	Interpretation of toposheets		
	3	Downloading of toposheets		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. "Introduction to Geographic Information Systems" by Kang-Tsung Chang (McGraw-Hill Education, 2018)
2. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman., (Wiley, 2015)
3. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind., (Wiley, 2015)

4. "Elements of Photogrammetry with Applications in GIS" by Paul R. Wolf, Bon A. Dewitt, and Benjamin E. Wilkinson., (McGraw-Hill Education, 2014)
5. "Principles of Geographic Information Systems" by Rolf A. de By and Henk J. Scholten (ITC,2010)
6. "The GIS 20: Essential Skills" by Gina Clemmer., (ESRI Press, 2013)

Programme	B. Sc. Geology				
Course Code	GEL2MN101				
Course Title	**GEOINFORMATICS - II**				
Type of Course	Minor				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	An intermediate level course for learners of geoinformatics				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will comprehend the classification of sensors and their parameters.	U	F	Exam
CO2	Students will learn about different types of multispectral sensors and hyperspectral imaging techniques.	Ap	C	Quiz
CO3	Students will understand the types of platforms used in geoinformatics	An	P	Assignment
CO4	Students will identify various sources of GIS data, different data models in GIS,	E	M	Viva
CO5	Students will develop skills in data management and editing within a GIS framework..	Ap	F	Assignment
CO6	Students will gain a comprehensive understanding of GNSS technologies, including GPS and GAGAN.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOINFORMATICS - II

Module	Unit	Content	Hrs	Marks
I	**Sensors**		10	15
	1	Classification of sensors		
	2	Sensor parameters – spatial, spectral, radiometric, temporal		
	3	Components of sensors		
	5	Multispectral sensors – pushbroom & whiskbroom scanners		
	6	Hyperspectral imaging		
	7	Atmospheric sensors, SONAR, LiDAR		
II	**Platforms**		15	20
	8	Types of platforms – Groundborne, Airborne (balloons, aircrafts, UAV), Spaceborne (sunsynchronous, geosynchronous)		
	9	Orbital elements - six elements of Keplerian orbit.		
	10	Types of satellite orbits – Sunsynchronous, Geosynchronous		
	11	GNSS – GPS, GAGAN		
	12	Types of platforms – Ground-borne, Airborne (balloons, aircrafts, UAV), Spaceborne (sunsynchronous, geosynchronous)		
III	**Data sources and data models of GIS**		15	20
	13	Sources of GIS data – introduction		
	14	Conventional analogue map sources – Topographical maps, Thematic maps, Geologic maps & Existing digital map sources		
	15	Aerial photographs & satellite imageries		
	16	Field data sources – Surveying & GPS		
	17	Reports & Publications		
	18	Data models in GIS		
	18	Spatial data model – Raster & Vector		
	19	Attribute data model – hierarchical, network, relational		
IV	**Data Management and Editing in GIS**		5	15
	20	Data base management system		
	21	Data management in GIS		
	22	Data editing: Detecting and correcting errors		
	23	Data reduction, Generalization, Transformation		
	24	Rubber Sheeting and edge matching		
V	**Practicals**		30	10
	25	Georeferencing		
	26	Preparation of different thematic layers		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. "Introduction to Remote Sensing" by James B. Campbell and Randolph H. Wynne (Guilford Press, 2011)
2. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman (Wiley, 2015)
3. "Fundamentals of Remote Sensing" by George Joseph., (Universities Press, 2005)
4. "Remote Sensing Digital Image Analysis" by John A. Richards., (Springer, 2013)
5. "Principles of Geographical Information Systems" by Peter A. Burrough and Rachael A. McDonnell., (Oxford University Press,1998)
6. "GNSS Applications and Methods" by Scott Gleason and Demoz Gebre-Egziabher., Artech House, 2009)

Programme	B. Sc. Geology				
Course Code	GEL3MN201				
Course Title	**GEOINFORMATICS - III**				
Type of Course	Minor				
Semester	III				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	Advanced course for beginners in Geoinformatics				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will demonstrate a thorough understanding of optical remote sensing thermal remote sensing, and microwave remote sensing (	U	F	Exam
CO2	Students will gain proficiency in digital image processing techniques, enabling them to extract meaningful information from remote sensing data.	Ap	P	Practical Assignment
CO3	Students will apply remote sensing techniques to various domains.	Ap	P	Assignment
CO4	Students will learn about database management systems (DBMS) and data management techniques in GIS.	E	M	Viva
CO5	Students will explore the diverse applications of gaining practical skills in utilizing GIS	Ap	F	Practical Assignment
CO6	Students will integrate remote sensing and GIS techniques to address real-world challenges and applications.	E	M	Practical Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOINFORMATICS - III

Module	Unit	Content	Hrs	Marks
I	**Types of Remote Sensing**		**15**	**20**
	1	Optical remote sensing – panchromatic, multispectral, superspectral & hyperspectral		
	2	Thermal remote sensing: principles and applications		
	3	Microwave remote sensing : Active & Passive		
	4	Radars: Synthetic Aperture Radar & Real Aperture Radar		
	5	Introduction to digital image processing		
	6	Preprocessing – Geometric and radiometric corrections		
	7	Image registration, enhancement & filtering		
	8	Image classification: Supervised & Unsupervised		
II	**Applications of Remote Sensing**		**10**	**15**
	9	Landuse land cover mapping		
	10	Agriculture – crop monitoring, crop damage assessment, NDVI		
	11	Geology – structural mapping, lineament extraction, mineral exploration		
	12	Hydrology – water quality monitoring		
	13	Mapping - planimetry, DEM, Topographic & BTM		
	14	Oceans – measurement of SST, oil spill detection		
III	**Data Management in GIS**		**10**	**20**
	15	DBMS & Data management in GIS		
	16	Topology and spatial relationships- adjacency, containment, connectivity		
	17	Database query		
	18	Geospatial measurement		
	19	Overlay operations		
	20	Network analysis		
	21	Surface analysis		
IV	**Applications of GIS**		**10**	**15**
	22	Facilities Management		
	23	Environment and Natural Resources Management		
	24	Street Network		
	25	Planning and Engineering		
	26	Land Information System		
V	**Practical**		**30**	**10**
	27	Attribute data entry		
	28	Map layout		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. "Introduction to Geographic Information Systems" by Kang-Tsung Chang (McGraw-Hill Education, 2018)
2. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman., (Wiley, 2015)
3. "Geographic Information Systems and Science" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind., (Wiley, 2015)
4. "Elements of Photogrammetry with Applications in GIS" by Paul R. Wolf, Bon A. Dewitt, and Benjamin E. Wilkinson., (McGraw-Hill Education, 2014)
5. "Principles of Geographic Information Systems" by Rolf A. de By and Henk J. Scholten (ITC,2010)
6. "The GIS 20: Essential Skills" by Gina Clemmer., (ESRI Press, 2013)
7. "Introduction to Remote Sensing" by James B. Campbell and Randolph H. Wynne (Guilford Press, 2011)
8. "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman (Wiley, 2015)
9. "Fundamentals of Remote Sensing" by George Joseph., (Universities Press, 2005)
10. "Remote Sensing Digital Image Analysis" by John A. Richards., (Springer, 2013)
11. "Principles of Geographical Information Systems" by Peter A. Burrough and Rachael A. McDonnell., (Oxford University Press,1998)
12. "GNSS Applications and Methods" by Scott Gleason and Demoz Gebre-Egziabher., Artech House, 2009)

Minor Courses – Group 2

Programme	B. Sc. Geology				
Course Code	GEL1MN102				
Course Title	**PHYSICAL GEOLOGY**				
Type of Course	**Minor**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	NIL				
Course Summary	This course serves as an introduction to the field of geology, covering fundamental concepts related to Earth's formation, dimensions, dynamic evolution, geochronology, and major geological hazards.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will have an understanding of the basic principles and concepts of geology, including the formation of Earth and its dimensions.	U	F	Exam
CO2	Students will be able to explain the theories of Earth's formation and its physical dimensions, including the structure and composition of Earth's interior layers.	Ap	C	Home assignments
CO3	Students will analyze the dynamic processes that have shaped Earth's surface and interior over geological time scales, including plate tectonics, mountain building, erosion, and sedimentation.	An	P	Seminar presentations
CO4	Students will be able to interpret geochronological data and understand the methods used to determine the ages of rocks	E	M	Home assignments
CO5	Students will identify and describe major geological hazards, including earthquakes, volcanic eruptions, and understand the geological processes that cause them.	Ap	F	Assignment
CO6	Students will evaluate strategies for mitigating the impacts of geological hazards on society and the environment.	E	M	Practical Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: PHYSICAL GEOLOGY

Module	Unit	Content	Hrs	Marks
I		**Introduction to Geology**	**10**	
	1	Geology: The Science of Earth	2	
	2	The Development of Geology	3	**15**
	3	The Nature of Scientific Inquiry	2	
	4	Plate Tectonics and Scientific Inquiry	3	
II		**Earth's Formation and Dimensions**	**15**	
	5	Earth's Spheres	3	
	6	Earth System	3	
	7	Evolution of Earth	2	**20**
	8	Formation of Earth's layered structure	2	
	9	Earth's Internal Structure	2	
	10	Layers defined by Physical Properties	3	
III		**Changing Earth & Geochronology**	**10**	
	11	The Rock Cycle	2	
	12	The face of Earth. Mountain building. Origin & evolution of ocean floor	2	
	13	Age of the earth	2	**15**
	14	Dating methods: Absolute (radiometric) and relative (stratigraphy)	2	
	15	Application of dating methods in constructing the Geological Time Scale	1	
	16	Overview of eras, periods, epochs – major geological events.	1	
IV		**Introduction to Major Geological Hazards**	**10**	
	17	Volcanoes & Volcanic Hazards	1	
	18	Nature of Volcanic Eruptions and Products	1	
	19	Types of Volcanoes & Volcanic Landforms	2	**20**
	20	Earthquakes & Earthquake Hazards	2	
	21	Seismology, Seismic Waves, Earthquakes & Plate Boundaries	2	
	22	Earthquake Destruction. Prediction, Forecast and Mitigation	2	
V		**Practical**	**30**	
	1	Lab exercises to apply the concepts of interior of earth, earth's magnetism and plate tectonics. Exploring geologic features using Google Earth.	20	**20**
	2	Introduction to Topographic Maps. Exercises involving contour lines.	4	
	3	Application of Gt. Aide (Academy) Freeware	6	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	4 Theory Modules (10)	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Condie, K.C., 2015. *Earth as an Evolving Planetary System,* 3rd Edition, Academic Press, USA.
2. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA
3. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
4. Wicander, R. and Monroe, J., 2006. *Essentials of Geology.* 4th Edition, Thomson Learning Inc., USA.
5. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA

Programme	B. Sc. Geology				
Course Code	GEL2MN102				
Course Title	**GEOMORPHOLOGY**				
Type of Course	**Minor**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	0	2	75
Pre-requisites	NIL				
Course Summary	This course summarises the actions of various geological agents responsible for the formation of landforms. The processes and features produced thereof is explained in this geomorphology course.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Assess the various exogenous process in molding the earth's surface	Ev	C	Exams/ Quiz
CO2	Examine the origin, types, and effects of mass wasting	An	C	Assignment/ Exams
CO3	Distinguish various morphological features resulting from geological actions of running water.	Un	C	Practical Assignment/Exams
CO4	Describe the basic concepts on the distribution and occurrence of groundwater	An	C	Assignments/ Exams
CO5	Distinguish various morphological features resulting from geological actions of wind and glacier.	An	C	Practical Assignment /Exams
CO6	Distinguish various morphological features of ocean floor and coastal region resulting from geological processes	Un	P	Practical Assignment/ Internal exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOMORPHOLOGY

Module	Unit	Content	Hrs	Marks
I		**Mass Wasting & Running Water**	**10**	**25**
	1	The Importance of Mass Wasting. Landslides as Geologic Hazards	1	
	2	Mass Wasting in Landform Development	1	
	3	Controls and Triggers of Mass Wasting	2	
	4	Hydrologic Cycle. Drainage basin and drainage patterns	2	
	5	Graded, Braided, and Meandering streams	1	
	6	Geological work of streams: Erosional and depositional fluvial landforms	2	
	7	Base level, Rejuvenation, Knick Points, River Piracy	1	
II		**Groundwater**	**10**	**10**
	8	Underground water: Occurrence.Water table, porosity, permeability	3	
	9	Aquifers: Confined and unconfined, aquicludes, aquitard, and aquifuge.	3	
	10	Natural Springs and types	2	
	11	Geological work of groundwater, Karst Topography	2	
III		**Glacier & Wind**	**15**	**20**
	10	Ice Sheets. Types of glaciers	2	
	11	Formation and movement of glacial ice	2	
	12	Glacial erosion and features produced by glacial erosion	3	
	13	Glacial deposits. Concept of ice ages.	2	
	14	Global distribution of deserts. Formation of deserts.	2	
	15	Geological actions of wind: erosion, transportation & deposition	2	
	16	Processes and features associated with wind action	2	
IV		**Oceans**	**10**	**15**
	17	Oceans and Seas –distribution over earth	1	
	18	Waves, tides, currents, CCD, Marine sediments.	2	
	19	Types of continental margins	1	
	20	Ocean bottom topography.	2	
	21	Shoreline processes	2	
	22	Shoreline features	2	
V		**Practical**	**30**	**20**
	1	Stream ordering using toposheets	5	
	2	Google Earth application in understanding the global distribution of glaciers, deserts and oceans	20	
	3	Calculations involving sediment and water movement in streams	5	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (10)**	**Practical (20)**
1	Test paper/ **Continuous Evaluation of Practical Exercises**	5	**10**
2	Seminar/ **End Sem Exam &Viva-Voce**	3	7
3	Assignment / **Lab Record**	2	**3**

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Seminar	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

References:

1. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to PhysicalGeology. 9th Edition, Pearson Education, Inc., New Jersey, USA.

2. Wicander, R. and Monroe, J., 2006. Essentials of Geology. 4th Edition, Thomson Learning Inc., USA.

Programme	B. Sc. Geology				
Course Code	GEL3MN202				
Course Title	**HISTORICAL GEOLOGY**				
Type of Course	**Minor**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	2	75
Pre-requisites	Nil				
Course Summary	The course enables the students to get an overall view of the use of fossils in understanding the geological history and thereby to utilise that in stratigraphic classification				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The students will be able to describe fossils and their preservation	R	F	Instructor created exam/ Quiz
CO2	The students will be able to discuss different type of fossils and their uses	U	C	Home assignment
CO3	The students will be able to define various laws of stratigraphy	R	C	Home assignment
CO4	The students will be able to differentiate physical and biological criterias of correlation	An	P	Instructor created exam/ Group tutorial works
CO5	The students will be able to explain major events of mass extinction	U	F	Seminar presentation
CO6	The students will be able to explain different types of stratigraphic classification	U	C	Instructor created exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: HISTORICAL GEOLOGY

Module	Unit	Content	Hrs.	Marks
I		**Introduction to Palaeontology and Fossilization**	**10**	**15**
	1	Definition of Palaeontology	1	
	2	Organic world classification: Flora and Faun	2	
	3	Fossils & Fossilisation: Petrifaction, permineralization, carbonization, recrystallization, silicification, amber preservation, mummification.	4	
	4	Types of fossils: Body fossil, moulds, casts, tracks, trails, borings	3	
II		**Uses of Fossils and Laws of Stratigraphy**	**15**	**25**
	5	Uses of fossils: Stratigraphic, climatic and palaeogeographic indicators	2	
	6	Fossils as indicators of evolution and migration of life forms	2	
	7	Fossils: indicators of new deposits of coal and petroleum	1	
	8	Laws of Stratigraphy: Concept of uniformitarianism	1	
	9	Law of order of superposition, Law of faunal succession and Law of original horizontality	2	
	10	Principle of Lateral Continuity, Principle of Inclusion, Law of cross-cutting relationship	2	
	11	Correlation: Physical criteria of correlation	3	
	12	Biological criteria of correlation and homotaxis	2	
III		**Major Events of Mass Extinction, Facies Changes, and Stratigraphic Classification**	**10**	**20**
	13	Major events of Mass extinction: Ordovician-Silurian and late Devonian extinction events	2	
	14	Permian- Triassic and Cretaceous- Tertiary extinction events	2	
	15	Facies and facies changes: Litho and bio facies	2	
	16	Break in stratigraphic records: Unconformities and diastems	1	
	17	Stratigraphic classification: Biostratigraphic classification: Biozones, biohorizon, index fossil. Range zone, taxon range zone, concurrent range zone, interval zone, assemblage zone, Acme zone	3	
	18	Lithostratigraphic classification: Group, Formation, Member, Bed	2	
	19	Chronostratigraphic classification: Eonothem, erathem, system, series, stage	1	
IV		**Application of Palaeontology in Earth Sciences**	**10**	**10**
	20	Practical applications of Palaeontology	4	
	21	Integration of fossil evidence in understanding Earth's history	3	
	22	Contemporary research and advancements in Palaeontology	3	
V		**Practical**	**30**	**10**
		Identify important fossils of stratigraphic significance		
		Exercises to familiarise with the laws of stratigraphy		
		Familiarise with World's Palaeontology Institutes / Museums		
		Discuss about the books / films that features palaeontology		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar	End Semester Examinations
CO 1			✓
CO 2	✓		
CO 3	✓		
CO 4		✓	✓
CO 5			
CO 6			✓

References:

1. Boggs, S., 2016. Principles of Sedimentology and Stratigraphy. Pearson Education. 568 p.
2. Brookfield, M.E., 2003. Principles of Stratigraphy. Wiley-Blackwell, 340 p.
3. Nichols, G., 2016. Sedimentology and Stratigraphy. Wiley-Blackwell, 419 p.
4. Henry woods: Invertebrate palaeontolgy – Cambridge.
5. Romer , A.S.: Vertebrate palaeontology, Chicago press.
6. Arnold, C.A., An introduction to Palaeobotany., MC-Graw Hill.
7. B.U. Haq and A. Boersma (1978) Introduction to marine Micropalaeontology. Elsevier,Netherlands
8. Raup, D.M. and Stanely, M.S.: Principles of Palaeontology, CBS Publishers.
9. Moore , R.C., Laliker , C.G.&Fishcher, A.G.: Invertebrate Fossils , Harper brothers
10. Shrock. R.R. and Twenhofel , W.H – 1953.: Principles of invertebrate Palaeontology, Amold publication.

Foundation Courses Offered by Major

Programme	B. Sc. Geology				
Course Code					
Course Title	**EXPLORING THE MOTHER EARTH**				
Type of Course	Foundation – Multi Disciplinary Course				
Semester	1				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	0	45
Pre-requisites	NIL				
Course Summary	A brief introduction to Earth and the geological processes				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts and principles of geology as a scientific discipline.	U	F	Exam
CO2	Describe the processes involved in Earth's formation, including differentiation and early geological history.	Ap	C	Quiz
CO3	Explain the principles and techniques of geochronology used to determine the ages of rocks and geological events.	An	P	Assignment
CO4	Interpret the geological time scale and recognize major landforms and geological features.	E	M	Viva
CO5	Identify the driving forces behind tectonic activity and plate movements.	Ap	F	Assignment
CO6	Identify geological hazards associated with plate tectonics	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: EXPLORING THE MOTHER EARTH

Module	Unit	Content	Hrs	Marks
I		**Introduction to Geology**	10	15
	1	Overview of Geology as a Science		
	2	Branches of Geology: Physical Geology vs. Historical Geology		
	3	Earth's Structure: Core, Mantle, Crust		
	4	Rock Cycle and Types of Rocks		
	5	Origin of the Solar System and Earth		
	6	Nebular Hypothesis and Planetesimal Accretion		
	7	Differentiation of Earth's Interior: Core, Mantle, and Crust		
	8	Earth's Spheres: Lithosphere, Hydrosphere, Atmosphere, Biosphere		
	9	Measurement of Earth's Dimensions: Circumference, Diameter, Mass		
II		**Early Earth Differentiation and Geochronology**	8	10
	9	Early Earth Conditions: Hadean, Archean, and Proterozoic Eons		
	10	Differentiation Processes: Formation of Earth's Layers		
	11	Principles of Radiometric Dating and Isotopic Decay		
	12	Geological Time Scale: Eons, Eras, Periods, and Epochs		
III		**Geological Time Scale and Landforms**	8	10
	13	Geological Time Scale: Overview and Major Events		
	14	Relative Dating Methods: Stratigraphy, Superposition, Cross-Cutting Relationships		
	15	Absolute Dating Methods: Radiometric Dating Techniques		
	16	Major Landforms and Geological Processes: Mountains, Plateaus, Valleys, Plains		
	17	Geomorphic Agents: Weathering, Erosion, Deposition, Tectonic Activity		
IV		**Tectonics and Plate Movements**	10	15
	18	Plate Tectonics Theory: Historical Development and Evidence		
	19	Types of Plate Boundaries: Divergent, Convergent, Transform		
	20	Geological Features Associated with Plate Boundaries: Mid-Ocean Ridges, Subduction Zones, Faults		
	21	Tectonic Forces and Earthquakes		
	22	Volcanic Activity and Geological Hazards		
V		**Open Ended Module**	9	5
	Discussing the new trends in exploring the Universe. Eg. James Web Space Telescope. Different Missions to various planetary bodies.			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. Condie, K.C., 2015. *Earth as an Evolving Planetary System,* 3rd Edition, Academic Press, USA.
2. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA
3. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
4. Wicander, R. and Monroe, J., 2006. *Essentials of Geology.* 4th Edition, Thomson Learning Inc., USA.
5. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA

Programme	B. Sc. Geology				
Course Code					
Course Title	**MINERALS, ROCKS & FASCINATING PLATE TECTONICS**				
Type of Course	Foundation – Multi Disciplinary Course				
Semester	2				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	0	-	45
Pre-requisites	NIL				
Course Summary	Basic introduction to minerals, rocks and plate tectonics				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify various types of minerals anddiscuss about their properties	R	F	Exams/ Quiz
CO2	Able to classify minerals based onvarious properties	U	C	Assignment/ Exams
CO3	Define rock cycle and categorise the rocks into different groups	U	F	Practical Assignment/ Exams
CO4	Illustrate fascinating facts about plate movements	U	C	Assignments/ Exams
CO5	Able to understand the consequences of plate movements	U	C	Assignments/ Exams
CO6	Demonstrate critical thinking and able to identify important minerals and rocks	Ap	P	Practical Assignment/Internal exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: MINERALS, ROCKS & FASCINATING PLATE TECTONICS

Module	Unit	Content	Hrs	Marks
I		**Minerals and Their Properties**	9	12
	1	Physical properties of minerals		
	2	Form,colour,streak		
	3	Hardness and types of lustre		
	4	Cleavage and Fracture, Electrical properties		
	5	Magnetic properties		
II		**Classification of Minerals**	9	12
	6	Rock forming Minerals		
	7	Ore forming Minerals		
	8	Silicates and Nonsilicates		
	9	Mafic		
	10	Felsic		
III		**Rocks And Rock Cycle**	9	12
	11	Concept of Rock cycle		
	12	Process of Rock formation and transformation		
	13	Igneous rocks, types with examples		
	14	Sedimentary rocks with examples		
	15	Metamorphic rocks with examples		
IV		**Plate Tectonics**	9	14
	16	Plate Tectonics theory		
	17	Types of Plate boundaries		
	18	Consequences of Tectonics		
	19	Volcano, Island Arcs, Ring of fire		
	20	Earthquake, Rift valley		
	21	Mid oceanic ridges, trenches		
	22	Mineral deposits associated with convergent plate margin		
V		**Open Ended Module**	9	5
	1	Plotting of major volcanoes related to plates		
	2	Plotting of earthquakes on world map based on intensity		
	3	Locating of earthquakes epicentre		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. Condie, K.C., 2015. *Earth as an Evolving Planetary System*, 3rd Edition, Academic Press, USA.
2. Hudson, T., 2012. *Living with Earth – An Introduction to Environmental Geology*. Pearson Education Inc., New Jersey, USA
3. Marshak, S., 2001. *Earth: Portrait of a Planet.* W.W. Norton & Co., Inc., USA
4. Wicander, R. and Monroe, J., 2006. *Essentials of Geology.* 4th Edition, Thomson Learning Inc., USA.
5. Tarbuck, E.J. and Lutgens, F.K., 2008. Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA

Programme	B. Sc. Geology				
Course Code	GEL3FV108_				
Course Title	**GEOLOGY & SUSTAINABLE DEVELOPMENT GOALS**				
Type of Course	Foundation – Value Added Course				
Semester	III				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	0	45
Pre-requisites	NIL				
Course Summary	Course in Geology & Sustainable Development Goals provides students with a comprehensive understanding of the intersections between geology and global sustainability initiatives, through exploration of the United Nations Sustainable Development Goals (SDGs).				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the interconnectedness between geology and the Sustainable Development Goals (SDGs) and the role of geology in addressing global challenges.	U	F	Exam
CO2	Analyze the geological drivers and impacts of climate change and evaluate geologically-based solutions for climate action and adaptation (SDG 13).	Ap	C	Quiz
CO3	Apply geological principles to the management of water resources, including groundwater exploration, and contamination mitigation (SDG 6).	An	P	Assignment
CO4	Critically evaluate the environmental and social implications of resource extraction activities and apply principles of responsible resource management (SDG 12).	E	M	Viva
CO5	Assess the role of geology in biodiversity conservation, habitat preservation, and ecosystem restoration efforts to promote life on land (SDG 15).	Ap	F	Assignment
CO6	Advocate effectively about the intersections between geology and SDGs	E	M	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: GEOLOGY & SUSTAINABLE DEVELOPMENT GOALS

Module	Unit	Content	Hrs	Marks
I		**Introduction to Sustainable Development Goals (SDGs)**	9	10
	1	Overview of the United Nations Sustainable Development Goals (SDGs)		
	2	Linkages between geology, Earth sciences, and the SDGs		
	3	Importance of geology in achieving sustainable development		
	4	Interdisciplinary approach to addressing global challenges through the SDGs		
	5	Overview of the United Nations Sustainable Development Goals (SDGs)		
II		**Geology and Climate Action (SDG 13)**	9	10
	6	Understanding climate change and its geological drivers		
	7	Impacts of climate change on geology, including sea level rise, glacier retreat, and extreme weather events		
	8	Role of geology in climate mitigation and adaptation strategies		
	9	Carbon capture and storage technologies and geological sequestration		
	10	Understanding climate change and its geological drivers		
III		**Geology and Clean Water & Sanitation (SDG 6)**	9	10
	11	Geology of water resources: aquifers, groundwater recharge, and contamination pathways		
	12	Groundwater exploration and management techniques		
	13	Geohydrology and its role in providing clean water and sanitation services		
	14	Geological hazards related to water, such as floods, landslides, and droughts		
IV		**Geology and Responsible Resource Management (SDG 12 & 15)**	9	20
	15	Geological exploration and sustainable extraction of mineral and energy resources		
	16	Environmental impacts of resource extraction and land use change		
	17	Geological hazards associated with resource extraction activities		
	18	Sustainable development of geological resources for economic and social benefit		
	19	Geology's role in biodiversity conservation and habitat preservation		
	20	Land degradation and desertification: geological causes and solutions		
V		**Open Ended Module**	9	5
		Discussion on SDGs with particular reference to India and Kerala		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. "Geology and the Sustainable Development Goals" edited by Graham B. Shimmield and Clive B. Richardson. Publisher: Geological Society of London. Year of Publication: 2018
2. "Sustainable Development in Mineral Economies" by Richard Auty. Publisher: Oxford University Press. Year of Publication: 2014
3. "Geology and the Environment" by Bernard W. Pipkin, D.D. Trent, and Richard W. Hazlett. Publisher: Cengage Learning. Year of Publication: 2007

Programme	B. Sc. Geology				
Course Code	GEL4FV110				
Course Title	**WATER CONSERVATION TECHNIQUES**				
Type of Course	Foundation – Value Added Course				
Semester	VII				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	0	45
Pre-requisites	NIL				
Course Summary	The Water Conservation Techniques course equips students with the knowledge and skills necessary to address the growing challenges of water scarcity and sustainable water management.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of water conservation	U	F	Exam
CO2	Identify and evaluate various water conservation technologies and practices for different sectors.	Ap	C	Quiz
CO3	Apply knowledge of sustainable land use practices and watershed management techniques	An	P	Assignment
CO4	Analyze the role of stakeholders in effective water conservation strategies.	E	M	Viva
CO5	Critically evaluate case studies and real-world applications of water conservation techniques	Ap	F	Assignment
CO6	Communicate effectively about water conservation principles and technologies.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: WATER CONSERVATION TECHNIQUES

Module	Unit	Content	Hrs	Marks
I		**Introduction to Water Conservation**	9	10
	1	Overview of global water resources and challenges		
	2	Importance of water conservation in sustainable development		
	3	Historical perspectives on water use and conservation		
	4	Principles of water balance and conservation ethics		
II		**Water Conservation Technologies**	9	15
	5	Efficient irrigation techniques (drip irrigation, micro-sprinklers)		
	6	Rainwater harvesting systems		
	7	Greywater recycling and reuse		
	8	Green infrastructure for stormwater management		
III		**Sustainable Land Use Practices**	8	10
	9	Watershed management strategies		
	10	Soil conservation techniques		
	11	Agroforestry and sustainable agriculture practices		
	12	Urban planning for water-sensitive design		
IV		**Policy and Governance in Water Conservation**	10	15
	13	Water conservation policies and regulations at various levels		
	14	Economic incentives and pricing mechanisms for water conservation		
	15	Stakeholder engagement and community-based water management		
	16	Integrated water resources management approaches		
	17	Role of government agencies, NGOs, and private sector in water conservation		
	18	Case studies of successful water conservation projects and initiatives		
	19	Evaluation of water conservation strategies in different geographic and socio-economic contexts		
V		**Case Studies and Applications**	9	5

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. "Water Resources Engineering" by Larry W. Mays. Publisher: Wiley. Year: 2010
2. "Water Conservation Techniques" by D. K. Mishra. Publisher: IK International Publishing House Pvt Ltd. Year: 2016
3. "Handbook of Water and Wastewater Treatment Technologies" by Nicholas P. Cheremisinoff. Publisher: Butterworth-Heinemann. Year: 2002
4. "Sustainable Water Management: Principles and Practices" by Chittaranjan Ray. Publisher: Wiley. Year: 2014
5. "Water Harvesting for Groundwater Management: Issues, Perspectives, Scope, and Challenges" by R. S. Yadav. Publisher: CRC Press. Year: 2016.

Programme	B. Sc. Geology				
Course Code	GEL5FS112				
Course Title	**WATER QUALITY ASSESSMENT**				
Type of Course	Foundation - Skill Enhancement Course				
Semester	V				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	0	45
Pre-requisites	NIL				
Course Summary	The Water Quality Assessment course provides students with a comprehensive understanding of the principles, methodologies, and applications of assessing and managing water quality. Through a series of modules, students will explore the physical, chemical, and biological parameters that define water quality, as well as the techniques and tools used for water sample collection, analysis, and interpretation.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand water quality parameters	U	F	Exam
CO2	Understand biological assessment of water quality	Ap	C	Quiz
CO3	Applying the sampling techniques	An	P	Assignment
CO4	Applying the analytical techniques	E	M	Viva
CO5	Evaluate the water quality based on analytical data	Ap	F	Assignment
CO6	Describe water quality from the analytical data	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: WATER QUALITY ASSESSMENT

Module	Unit	Content	Hrs	Marks
I		**Introduction to Water Quality Assessment**	9	10
	1	Overview of water quality parameters		
	2	Importance of water quality assessment		
	3	Sources of water contamination		
	4	Basic principles of hydrology		
II		**Physical and Chemical Properties of Water**	9	15
	5	Physical properties of water (temperature, color, turbidity)		
	6	Chemical properties of water (pH, dissolved oxygen, conductivity)		
	7	Major ions and trace elements in water		
	8	Water hardness and alkalinity		
III		**Biological Assessment of Water Quality**	9	10
	9	Introduction to biological indicators		
	10	Macroinvertebrates as indicators of water quality		
	11	Microorganisms in water quality assessment		
	12	Role of aquatic plants in water quality monitoring		
IV		**Sampling and Analytical Techniques**	9	15
	13	Methods for water sample collection		
	14	Laboratory analysis techniques - spectrophotometry		
	15	Laboratory analysis techniques - chromatography		
	16	Quality assurance and quality control in water analysis		
	17	Field measurements and portable instrumentation		
	18	Case studies of water quality assessment in various environments		
	19	Regulatory frameworks for water quality management		
V		**Open Ended Module**	9	5
	18	Provide the analytical data of water samples and discuss about the quality		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. Principles of Water Quality Control" by T. H. Y. Tebbutt. Publisher: Butterworth-Heinemann. Year: 2018
2. "Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring" edited by Deborah Chapman. Publisher: CRC Press. Year: 1996

Programme	B. Sc. Geology				
Course Code	GEL6FS113				
Course Title	**CONTENT WRITING IN GEOLOGY**				
Type of Course	Foundation – Skill Enhancement Course				
Semester	III				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	0	45
Pre-requisites	NIL				
Course Summary	Content Writing in Geology provides students with the essential skills and knowledge to effectively communicate geological concepts, research findings, and insights to diverse audiences.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles and techniques of effective scientific communication in geology.	U	F	Exam
CO2	Demonstrate proficiency in writing scientific papers, reports, and technical documents following established conventions and formats.	Ap	C	Quiz
CO3	Develop skills in outreach and communication, including writing for different audiences and platforms in geology.	An	P	Assignment
CO4	Apply techniques for effectively communicating complex geological concepts and findings to diverse stakeholders.	E	M	Viva
CO5	Critically analyze and evaluate geology-related content in media and journalism.	Ap	F	Assignment
CO6	Communicate geology-related topics confidently through written assignments, presentations, and outreach materials.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: CONTENT WRITING IN GEOLOGY

Module	Unit	Content	Hrs	Marks
I		**Introduction to Geology Writing**	9	15
	1	Overview of geology as a scientific discipline and its importance in society		
	2	Understanding the audience: writing for scientists, policymakers, and the general public		
	3	Principles of effective scientific communication in geology		
	4	Basics of scientific writing: structure, clarity, and precision in writing		
II		**Scientific Papers and Reports**	9	15
	5	Anatomy of a scientific paper: abstract, introduction, methods, results, discussion, and conclusions		
	6	Writing techniques for each section of a scientific paper		
	7	Guidelines for citing sources and formatting references		
	8	Peer review process and responding to reviewer comments		
III		**Geology Outreach and Communication**	9	15
	9	Importance of outreach and communication in geology		
	10	Writing for different platforms: blogs, social media, websites, and newsletters		
	11	Strategies for engaging and educating diverse audiences about geological topics		
	12	Incorporating visuals (images, diagrams, maps) into geology outreach materials		
IV		**Technical Writing in Geology**	9	15
	13	Writing technical reports, proposals, and project summaries		
	14	Communicating geological findings and interpretations to stakeholders		
	15	Guidelines for writing field notes and logs		
	16	Incorporating data analysis and interpretation into technical writing		
	17	Role of geology in the media landscape		
	18	Writing news articles and features on geological discoveries and events		
	19	Ethical considerations in science journalism		
V		**Open Ended Module**	9	5
		Discussing the new discoveries and give practical assignments.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
External evaluation: 50 marks. Internal Evaluation: 25 marks

INTERNAL MARK SPLIT-UP (TOTAL 25 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (5)**
1	Test paper/ Mid semester Exam	10	2.5
2	Seminar/ Viva/ Quiz	6	1.5
3	Assignment/ Group Discussion	4	1

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓	✓	✓
CO 2	✓	✓	✓
CO 3		✓	✓
CO 4		✓	✓
CO 5		✓	✓
CO6		✓	✓

References:

1. "Writing for Science and Engineering: Papers, Presentations and Reports" by Heather Silyn-Roberts., Publisher: Butterworth-Heinemann. Year of Publication: 2002
2. "The Craft of Scientific Writing" by Michael Alley: Springer. 1996
3. "Writing Geology" by Stephen J. Reynolds, Julia K. Johnson, and Paul R. Morin.
4. W. H. Freeman. 2011
5. "Effective Writing in the Geosciences: A Guide to Scientific Communication" by Jonathon M. Winkler. John Wiley & Sons. : 2016
6. "Scientific Writing and Communication: Papers, Proposals, and Presentations" by Angelika H. Hofmann. Oxford University Press.: 2014.

Elective Courses

Programme	B Sc Geology				
Course Code	GEL5EJ301				
Course Title	**MINE PLANNING & RESOURCE ESTIMATION**				
Type of Course	Major - Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary	Mine Planning and Resource Estimation is an undergraduate-level course designed to provide students with an understanding of the principles, methods, and practices involved in planning and estimating resources for mining operations.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamentals of mine planning and resource estimation.	U	F	Instructor-created exams / Quiz
CO2	Analyze topographical features and drainage patterns relevant to mining operations.	An	C	Map Reading
CO3	Evaluate geological considerations in mine planning, including overburden and orebody characteristics.	An	P	Assignment
CO4	Apply methods for estimating mineral reserves and resources.	C	P	Problem Solving
CO5	Assess different mining methods and their suitability for various geological conditions.	Ap	P	Test paper
CO6	Develop environmental management and closure plans for mining operations.	C	P	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: MINE PLANNING & RESOURCE ESTIMATION

Module	Unit	Content	Hrs	Marks
I		**Introduction to Mine Planning and Preparation**	**10**	**15**
	1	Overview of mine planning process	2	
	2	Introduction to various minerals (e.g., building stone, iron ore, limestone)	2	
	3	Importance of mine plans in mining operations	2	
	4	Regulatory requirements and compliance	2	
II		**Topography, Drainage, and Geology**	**10**	**15**
	5	Understanding topographical maps and features	2	
	6	Drainage patterns and their implications for mine design	2	
	7	Geological considerations in mine planning (overburden, orebody/building stone)	2	
	8	Integration of topography and geology in mine planning	2	
III		**Reserve Estimation and Mining Methods,**	**9**	**20**
	9	Techniques for reserve estimation (e.g., geological modeling, geostatistics)	2	
	10	Determination of mineral resources and reserves	2	
	11	Overview of different mining methods (open-pit, underground, surface)	1	
	12	Selection of mining methods based on geological and economic factors	2	
IV		Environmental Management,Closure Planning, Socio-Economic & Environmental Monitoring	**19**	**20**
	13	Baseline data collection for environmental impact assessment	2	
	14	Preparation of environmental management plans and mine closure plans	1	
	15	Action plans for environmental protection and mitigation measures	2	
	16	Safety, security, disaster management, and risk assessment in mining operations	2	
	17	Baseline data collection for environmental impact assessment	1	
	18	Preparation of environmental management plans and mine closure plans	1	
	19	Assessment of socio-economic benefits and impacts of mining activities	1	
	20	Monitoring and management of environmental degradation	1	
	21	Solid waste management and mitigation measures	2	
	22	Environmental monitoring of air quality, water quality, noise pollution, and ground vibrations	2	
V		**Open-ended Module**	**12**	**10**
		Try to make mine plans from secondary data collected from various sources.		

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Open Pit Mine Planning and Design" by William Hustrulid and Mark Kuchta (CRC Press, 2013)
2. "Introductory Mining Engineering" by Howard L. Hartman and Jan M. Mutmansky (Wiley, 2002)
3. "Mine Planning and Equipment Selection" edited by Raj K. Singhal (CRC Press, 2011)
4. "Environmental Impacts of Mining Activities: Emphasis on Mitigation and Remedial Measures" by Mritunjoy Sengupta (Springer, 1993)
5. "SME Mining Engineering Handbook" edited by Peter Darling (Society for Mining, Metallurgy, and Exploration, 2011)
6. "Geological Methods in Mineral Exploration and Mining" by Roger Marjoribanks (Springer, 2010)
7. "Environmental Management in the Australian Minerals and Energy Industries: Principles and Practices" edited by David S. Baldwin, Niven Winchester, and Ross W. Dixon., (UNSW Press, 1993)
8. "Mining Environmental Handbook: Effects of Mining on the Environment and American Environmental Controls on Mining" by Jerrold J. Marcus., (Imperial College Press,1997)
9. "Geostatistical Ore Reserve Estimation" by M. David.,(Elsevier, 1977)
10. "Mine Closure and Sustainable Development" edited by Brock A. Lebeck (Springer, 2019)
11. "Rock Mechanics for Natural Resources and Infrastructure Development" edited by Sergio A. Buzzi, Eduardo E. Alonso, and Noel A. C. Brady., (CRC Press, 2019)

Programme	B. Sc. Geology				
Course Code	GEL5EJ302				
Course Title	**GEOTECHNICAL ENGINEERING**				
Type of Course	Major - Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Geotechnical Engineering for Geology is a specialized course designed to bridge the gap between geological principles and their application in geotechnical engineering practices. This course emphasizes the geological aspects of soil and rock behavior, site investigation techniques, and geotechnical design considerations.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the relationship between geological processes and geotechnical engineering principles.	U	F	Instructor-created exams / Quiz
CO2	Demonstrate proficiency in geological site investigation techniques and interpretation of geological data.	An	C	Assignment
CO3	Analyse the geotechnical properties of rocks and soils based on geological characteristics.	An	P	Assignment
CO4	Apply geotechnical design principles in geological settings, considering factors such as slope stability and ground conditions.	C	P	Problem Solving
CO5	Evaluate geological hazards and their implications for engineering projects, and implement appropriate mitigation measures.	Ap	P	Test paper
CO6	Communicate effectively about geological aspects of geotechnical engineering projects and propose solutions to geological challenges.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: GEOTECHNICAL ENGINEERING

Module	Unit	Content	Hrs	Marks
I	1	Geo-technical engineering as a field science related to construction..,	6	10
	2	Scope of geotechnical engineering		
	3	Ground investigations – Introduction		
	4	Types of ground investigation, Geological mapping for ground investigation		
II	5	Field investigations - Introduction,	10	20
	6	Excavations and boreholes - Shallow trial pits, Deep trial pits and shafts,		
	7	Headings (adits),		
	8	Hand auger boring, Light cable percussion drilling,		
	9	Mechanical augers, Wash boring and other methods,		
	10	Backfilling excavations and boreholes.		
	11	Sampling the ground - General principles, Sample quality.		
	6	Disturbed samples from boring tools or from excavating equipments		
	7	Types of samplers - Open-tube samples and samplers,		
	8	Stationary piston sampler, Continuous soil sampling, Sand samplers, Rotary core samplers,		
	9	Window sampler, Block samples. Handling and labelling of samples.		
III	10	Field and lab tests Field tests – Introduction, tests.	16	20
	10	Tests in boreholes - Standard penetration test (SPT).		
	11	Permeability test and Packer test.		
	12	Pressure meter test. Pumping		
	13	Geophysical surveying (Electrical resistivity, Gravity, Magnetic, Seismic methods.		
	14	Laboratory tests on samples - Tests on soil -,		
	15	Classification tests - Moisture content/ water content determination		
	16	Liquid and plastic limits (Atterberg Limits),		
	17	Particle size distribution (grading) by sieving.		
	18	Soil strength tests - Triaxial compression test and unconfined compression test.		
	19	Compaction-related tests - Dry density (dry unit weight).		
IV	20	Logging - Description of soils and rocks Description of soils - Mass characteristics of soils.	16	20
	21	Material characteristics of soils – Colour, Particle shape, grading and composition.		
	22	Description and classification of rocks - General description - Strength of rock material, Structure, Colour, Texture, Grain size, State of weathering		
	23	Total core recovery (TCR), solid core recovery (SCR), Rock Quality Designation (RQD).		
V	**Open Ended Module**		12	10
	Students may be exposed to a material laboratory and the tests may be experienced.			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Principles of Geotechnical Engineering" by Braja M. Das.
2. "Foundation Design: Principles and Practices" by Donald P. Coduto, William A. Kitch, and Man-chu Ronald Yeung.

Programme	B. Sc. Geology				
Course Code	GEL5EJ303				
Course Title	**ENVIRONMENTAL GEOLOGY**				
Type of Course	**Major - Elective**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-		60
Pre-requisites	NIL				
Course Summary	A basic course in Environmental Geology				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Able to describe the scientific methods as applied in the earth sciences and explain the fundamental concepts	U	F	Exams/ Quiz
CO2	Identify the role of human to shape our environment	R	C	Assignment/ Exams
CO3	Describe various geologic hazards and its impact on earth	U	F	Assignment/ Exams
CO4	Discuss about the types of water pollution and categorize them	U	C	Assignments/ Exams
CO5	Explain about Air pollution,effects and various strategies to reduce it.	U	C	Seminars/ Exams
CO6	Discuss about various waste disposal methods and different types of energy resources	U	C	Assignment/ Internal exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ENVIRONMENTAL GEOLOGY

Module	Unit	Content	Hrs	Marks
I		**Our Place in the Environment**	**10**	**15**
	1	Geology as a basic environmental science		
	2	Fundamental concepts of environmental Geology		
	3	Obligation to the future, Earth place in space		
	4	Man as a Geologic agent, Deforestation		
	5	Population explosion and Urbanisation		
II		**Man and Geologic Hazards**	**10**	**15**
	6	Mass wasting and its human impacts		
	7	Slope stability- Factors		
	8	Earthquake Hazards and Risks		
	9	Prediction and control of earthquake		
III		**Man and Hydrospere**	**15**	**20**
	10	Surface water pollution and treatment		
	11	Point source and Non-point source		
	12	Ground water pollution and treatment		
	13	Sources of Groundwater pollution, salt water intrusion and acid rain		
	14	Marine water pollution		
\ IV		**Man and Atmosphere**	**13**	**20**
	15	Air pollution, Sources		
	16	Effects of air pollution , Global warming		
	17	Greenhouse gases, Ozone depletion		
	18	Strategies to reduce global warming		
	19	Waste management, prevention, minimization, reuse and recycling		
	20	Waste disposal methods		
	21	Environmental Impacts of mining and Mine site decommissioning		
	22	Global energy scenario and Alternative source of energy		
V		**Open Ended Module**	12	10

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Environmental Geology" by Carla W. Montgomery.,(McGraw-Hill Education, 2010)
2. "Environmental Geology" by Edward A. Keller., (Pearson, 2011)
3. "Principles of Environmental Geochemistry" by G. Nelson Eby (Thomson Brooks/Cole, 2004)
4. "Environmental and Engineering Geology" by David K. Todd and Larry W. Mays

(John Wiley & Sons, 2005)
5. "Introduction to Environmental Geology" by Edward A. Keller., (Pearson, 2013)
6. "Environmental Geology: An Earth System Science Approach" by Dorothy Merritts, Kirsten Menking, and Andrew de Wet (W. H. Freeman, 2014)
7. "Environmental Geology Workbook" by Jack W. Travis., (Wiley, 2009)
8. "Essentials of Geology" by Stephen Marshak., (W. W. Norton & Company, 2016)
9. "Environmental Geology Laboratory Manual" by Tom Freeman (Prentice Hall, 2010)
10. "Applied Geomorphology: Theory and Practice" edited by R. J. Allison., (Wiley, 2002)
11. "Environmental Hydrogeology" by Philip E. LaMoreaux and Judy T. Tanner., (CRC Press, 2001)

Programme	B. Sc. Geology				
Course Code	GEL6EJ304				
Course Title	**NATURAL DISASTER MANAGEMENT**				
Type of Course	Major - Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Natural Disaster Management is a multidisciplinary course that examines the causes, impacts, and management strategies associated with natural disasters. This course explores the scientific principles underlying natural hazards, risk assessment methodologies, disaster preparedness, response, and recovery measures.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the causes, mechanisms, and impacts of natural disasters on human societies and the environment.	U	F	Instructor-created exams / Quiz
CO2	Apply hazard assessment and risk analysis methodologies to evaluate vulnerability and resilience to natural hazards.	An	C	Map Reading
CO3	Develop disaster preparedness plans and response strategies for different types of natural disasters.	An	P	Assignment
CO4	Analyse post-disaster recovery and reconstruction processes and implement sustainable development measures	C	P	Report Writing
CO5	Evaluate the effectiveness of disaster management policies and practices in mitigating the impacts of natural disasters.	Ap	P	Test paper
CO6	Communicate effectively about natural disaster management concepts, principles, and strategies.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: NATURAL DISASTER MANAGEMENT

Module	Unit	Content	Hrs	Marks
I	1	Definition and classification of natural disasters	8	10
	2	Overview of natural hazard types (earthquakes, hurricanes, floods, wildfires, etc.)		
	3	Causes and mechanisms of natural disasters		
	4	Historical and global perspectives on natural disasters		
II	5	Hazard identification and vulnerability assessment	10	15
	6	Risk analysis methodologies (probabilistic, deterministic)		
	7	Spatial analysis techniques for mapping hazard zones		
	8	Socioeconomic factors influencing disaster risk		
III	9	Disaster planning and preparedness measures	10	20
	10	Emergency response coordination and management		
	11	Early warning systems for natural hazards		
	12	Search and rescue operations and evacuation procedures		
IV	13	Post-disaster damage assessment and needs analysis	20	25
	14	Rehabilitation and reconstruction strategies		
	15	Community-based approaches to recovery		
	16	Long-term resilience building and sustainable development		
	17	Analysis of case studies of major natural disasters (e.g., Hurricane Katrina, Turkey earthquake, Kerala floods)		
	18	Field visits to disaster-prone areas and emergency management facilities		
	19	Simulation exercises and role-playing scenarios for disaster response and recovery		
	20	Risk assessment		
	21	Disaster preparedness plans		
	22	Post-disaster recovery strategies		
V	**Open Ended Module**		12	10
	Discussion on different natural disasters and its management.			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Introduction to International Disaster Management" by Damon P. Coppola 2015, Butterworth-Heinemann.
2. "Natural Hazards and Disasters" by Donald Hyndman and David Hyndman 2018. Cengage Learning.
3. "Disaster Risk Management: A Reader" edited by Deborah S. Rogers 2009. Routledge.
4. "Emergency Management: Principles and Practice for Local Government" by Thomas D. Phelan. 2016. International City/County Management Association (ICMA).
5. "Natural Disaster Management" by Irmak Renda-Tanali 2014. CRC Press.
6. "Handbook of Disaster Research" edited by Havidan Rodriguez, Enrico L. Quarantelli, and Russell R. Dynes. 2007. Springer.

Programme	B. Sc. Geology				
Course Code	GEL6EJ301				
Course Title	**SURVEY TECHNIQUES**				
Type of Course	Major - Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	This course introduces students to various survey techniques used in both terrestrial and marine environments. Students will learn about the history of survey techniques, as well as the equipment and methods used for topographic and bathymetric surveys. The course covers data acquisition, processing, interpretation, and map preparation.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the historical development and evolution of survey techniques.	U	F	Instructor-created exams / Quiz
CO2	Demonstrate proficiency in conducting topographic surveys and creating elevation contours.	An	C	Map Reading
CO3	Demonstrate proficiency in conducting bathymetric surveys and creating bathymetric contours.	An	P	Assignment
CO4	Identify and operate different types of topographic survey equipment, including Total Station, GPS, DGPS, Drone, and LIDAR.	C	P	Problem Solving
CO5	Identify and operate different types of bathymetric survey equipment, including Single Beam Echosounder and Multi Beam Echosounder.	Ap	P	Test paper
CO6	Acquire, process, interpret survey data, and prepare maps using appropriate software.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: SURVEY TECHNIQUES

Module	Unit	Content	Hrs	Marks
I	1	Introduction to Survey Techniques	10	15
	2	History of Survey Techniques		
	3	Introduction to Topographic and Bathymetric Survey		
	4	Creation of Elevation Contours		
	5	Creation of Bathymetric Contours		
II	6	Topographic Survey Equipment	12	20
	7	Total Station		
	8	GPS (Global Positioning System)		
	9	DGPS (Differential Global Positioning System)		
	10	Drone Surveying		
	11	LIDAR (Light Detection and Ranging)		
III	12	**Bathymetric Survey Equipment**	10	15
	13	Single Beam Echosounder		
	14	Multi Beam Echosounder		
IV	15	**Data Acquisition and Processing**	16	20
	16	Acquiring Survey Data		
	17	Processing Survey Data		
	18	Interpretation of Survey Data		
	19	Preparation of Maps		
	20	Integration of survey data with GIS		
	21	Acquiring satellite data for surveying		
	22	Cadastral mapping with mobile applications		
V	**Open Ended Module**		12	10
		Survey can be conducted in the compound of the HEI and the data could be used with GIS applications.		

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Elementary Surveying: An Introduction to Geomatics" by Charles D. Ghilani and Paul R. Wolf, (Pearson, 2017)
2. "Surveying: Theory and Practice" by James M. Anderson and Edward M. Mikhail, (McGraw-Hill Education, 2001)
3. "Topographic Surveying" by Herbert Michael Wilson, (McGraw-Hill Book Company, 1912 (Classic Reference)
4. "Principles of Geographical Information Systems" by Peter A. Burrough and Rachael A. McDonnell.,(Oxford University Press, 1998)
5. "Introduction to GPS: The Global Positioning System" by Ahmed El-Rabbany, (Artech House, 2002)
6. "Modern Surveying: A Comprehensive Review" by Arthur Bannister, Stanley Raymond, and Raymond Baker., (Pearson, 1998)
7. "UAV or Drones for Remote Sensing Applications" edited by Felipe Gonzalez Toro and Antonios Tsourdos.,(MDPI, 2018)
8. "LIDAR: Remote Sensing Technology and Applications" edited by Ralph Stockli, (Nova Science Publishers, 2019)
9. "Bathymetric Surveying" by William W. Sayre., (U.S. Government Printing Office, 1983)
10. "Surveying with Construction Applications" by Barry Kavanagh and Tom Mastin, (Pearson, 2014)

11. "Manual of Geospatial Science and Technology" edited by John D. Bossler, (CRC Press, 2010)
12. "Hydrographic Surveying" by W. Langeraar, (Elsevier, 1984)

Programme	B. Sc. Geology				
Course Code	GEL6EJ302				
Course Title	**OFFSHORE MINERAL RESOURCES & MINING**				
Type of Course	Major - Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary	This course provides an in-depth study of offshore mineral resources and mining techniques. Students will learn about the geological processes involved in the formation of offshore mineral deposits, exploration methods, and the technological advancements in offshore mining operations.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the geological processes responsible for the formation of offshore mineral deposits.	U	F	Instructor-created exams / Quiz
CO2	Identify and assess various offshore mineral resources, including polymetallic nodules, manganese crusts, and hydrothermal vents.	An	C	Map Reading
CO3	Understand the offshore mineral resource potential in a world perspective	An	P	Assignment
CO4	Understand the offshore mineral resource potential in an Indian perspective	C	P	Problem Solving
CO5	Evaluate exploration techniques used to locate and characterize offshore mineral deposits.	Ap	P	Test paper
CO6	Describe the technological advancements in offshore mining equipment and operations.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: OFFSHORE MINERAL RESOURCES & MINING

Module	Unit	Content	Hrs	Marks
I	1	Introduction to offshore mineral resources	12	15
	2	Offshore mineral resources in a world perspective		
	3	Offshore mineral resources maps		
	4	Formation and occurrences of offshore mineral resources		
	5	Manganese Nodules		
	6	Iron Manganese Crust and Nodules		
	7	Polymetallic Sulphides		
II	8	Offshore mineral resources in Indian perspective	16	20
	9	Sand		
	10	Limemud		
	11	Heavy Mineral Placers (Ilmenite, Rutile, Garnet, Zircon, Monazite and Sillimanite)		
	12	Iron Manganese crust and nodules		
III	13	Shallow water mining methods	10	15
	14	Dredging: Mechanical and Hydraulic		
	15	Pumping: Pneumatic and Eddy Pumps		
IV	16	Deep water mining methods	10	20
	17	Seabed towing mining systems		
	18	Continuous chain bucket mining systems		
	19	Shuttle boat mining systems		
	20	Pipeline lifting mining systems		
	21	Hydraulic suction		
	22	Robotic mining system		
V	**Open Ended Module**		12	10
	Field exposure to any one or two types of actual mining sites can be thought of. Discussion on the impacts of various types of mining may also be conducted.			

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	-	-	-	1	1	-	-	-	-	1	
CO 2	-	-	2	-	-	2	-	-	2	-	-	-	
CO 3	-	-	1	-	-	2	-	-	-	-	2	-	
CO 4	1	2	-	-	-	3	-	-	-	2	-	3	
CO 5	-	2	-	-	1	3	-	-	-	2	-	3	
CO 6	3	-	-	-	-	3	3	-	-	-	-	3	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Marine Minerals: Exploring Our New Ocean Frontier" edited by David A. Ross (Springer, 2013)
2. "Marine Mineral Resources" by Fillmore C. F. Earney (Taylor & Francis, 2005)
3. "Seabed Minerals and Mining" by Rahul Sharma (Springer, 2017)
4. "Marine Geology and Geotechnology of the South China Sea and Taiwan Strait" edited by Ronald C. Chaney, Zhen Shao, and Brian M. Page (Springer, 2018)
5. "Seafloor Geomorphology as Benthic Habitat: GeoHAB Atlas of Seafloor Geomorphic Features and Benthic Habitats" edited by Peter T. Harris and Elaine K. Baker (Elsevier, 2012)

6. "Marine Mineral Resources of India" by A.K. Ghosh
(Daya Publishing House, 2014)
7. "Dredging Engineering" by John B. Herbich
(McGraw-Hill, 2000)
8. "Marine Mining: Technologies and Applications" by Yongxian Song
(CRC Press, 2020)
9. "Seafloor Mineral Resources: Scientific Advances and Economic Perspectives" edited by Jens Greinert and Jens Bischof
(Wiley, 2015)
10. "Marine Mining: ROV Technologies and Applications" by Carl F. Hostetter
(Woodhead Publishing, 2012)

Programme	B. Sc. Geology				
Course Code	GEL6EJ303				
Course Title	**ENVIRONMENTAL IMPACT ASSESSMENT**				
Type of Course	Major - Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Environmental Impact Assessment (EIA) is a crucial process in environmental management and sustainable development. This course introduces students to the principles, methodologies, and regulatory frameworks of EIA.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles, methodologies, and regulatory frameworks of Environmental Impact Assessment.	U	F	Instructor-created exams / Quiz
CO2	Acquire skills in conducting EIA studies, including screening, scoping, impact assessment, and mitigation planning.	An	C	Test paper
CO3	Apply EIA tools and techniques to identify, predict, and evaluate environmental impacts of development projects.	An	P	Assignment
CO4	Analyse and interpret EIA reports and make recommendations for environmental management and decision-making.	C	P	Assignment
CO5	Evaluate the role of stakeholders and public participation in the EIA process.	Ap	P	Test paper
CO6	Communicate effectively about EIA concepts, methodologies, and findings through written reports, presentations, and discussions.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ENVIRONMENTAL IMPACT ASSESSMENT

Module	Unit	Content	Hrs	Marks
I	1	Definition and objectives of Environmental Impact Assessment	10	15
	2	Historical development and international context of EIA		
	3	Regulatory frameworks and legal requirements for EIA		
	4	Role of stakeholders in the EIA process		
II	5	Steps involved in the EIA process (screening, scoping, baseline studies, impact assessment, mitigation)	15	20
	6	Methods for identifying and evaluating environmental impacts		
	7	Techniques for predicting and assessing environmental risks		
	8	Guidelines and best practices for conducting EIA studies		
III	9	Use of Geographic Information Systems (GIS) in EIA	8	10
	10	Environmental modeling and simulation techniques		
	11	Social impact assessment methods		
	12	Cost-benefit analysis and economic valuation in EIA		
IV	13	Overview of national and international EIA regulations	15	25
	14	Environmental policy frameworks and their relationship to EIA		
	15	Role of EIA in sustainable development and environmental management		
	16	Emerging trends and challenges in EIA practice		
	17	Analysis of real-world EIA reports and case studies		
	18	Field visits to project sites undergoing EIA processes		
	19	Group exercises on scoping, impact assessment, and mitigation planning		
	20	Role-playing scenarios to simulate stakeholder consultations and decision-making in EIA		
	21			
	22			
V	**Open Ended Module**		12	10
		Discuss an EIA of any major project that is available in the public domain.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Environmental Impact Assessment: Theory and Practice" by Peter Wathern 2013. Routledge
2. "Environmental Impact Assessment: A Practical Guide" by Barbara J. Bramble and Robert B. Taylor. 2016. Wiley
3. "Introduction to Environmental Impact Assessment" by John Glasson, Riki Therivel, and Andrew Chadwick. 2012. Routledge
4. "Environmental Impact Assessment: Process, Practice, and Prospects in Australia" by Neil Kirby. 2014. Cambridge University Press
5. "Principles of Environmental Impact Assessment" by Lawrence Canter. 2005. CRC Press
6. "Environmental Impact Assessment: Cutting Edge for the 21st Century" edited by Matthew W. Cashmore. 2012. Wiley-Blackwell

Programme	B. Sc. Geology				
Course Code	GEL6EJ304				
Course Title	**GEOLOGY & CLIMATE CHANGE**				
Type of Course	Major – Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites					
Course Summary	The Geology & Climate Change course examines the geological evidence and processes underlying past, present, and future climate change. It explores the role of geological factors in shaping Earth's climate system and how changes in climate have influenced geological processes throughout Earth's history.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the geological evidence and processes associated with past and present climate change.	U	F	Instructor-created exams / Quiz
CO2	Analyze geological records to reconstruct past climate variations and understand their implications for Earth's climate system.	An	C	Assignment
CO3	Evaluate the role of geological factors in influencing climate feedbacks and stability.	An	P	Assignment
CO4	Assess the impact of human activities on the climate system and geological processes.	C	P	Problem Solving
CO5	Identify climate change-related geological hazards and apply risk management strategies.	Ap	P	Test paper
CO6	Communicate effectively about the geological aspects of climate change and their implications for society and the environment.	C	P	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: GEOLOGY & CLIMATE CHANGE

Module	Unit	Content	Hrs	Marks
I	1	Definition and significance of climate change	6	10
	2	Overview of Earth's climate system and its components		
	3	The role of geology in understanding past climate change		
	4	Geological processes influencing climate variability		
II	5	Proxy records of past climate change (ice cores, sediment cores, tree rings)	12	20
	6	Geological indicators of ancient climates (paleosols, fossil distributions, glacial deposits)		
	7	Reconstruction of past climate variations using geological data		
	8	Case studies of major climate events in Earth's history		
III	9	Feedback mechanisms in the climate system (carbon cycle, albedo feedback, ocean circulation)	15	20
	10	Impact of geological processes on climate stability (volcanism, tectonics, erosion)		
	11	Climate-induced changes in Earth's surface (sea level rise, landscape evolution)		
	12	Role of geology in regulating long-term climate trends		
IV	13	Climate change impacts on geological hazards (landslides, floods, coastal erosion)	15	20
	14	Interaction between climate change and geological hazards		
	15	Vulnerability assessment and risk management strategies for climate-related hazards		
	16	Case studies of climate-induced geological disasters		
	17	Anthropogenic influences on the climate system (greenhouse gas emissions, land use change)		
	18	Impact of human activities on geological processes and landscapes		
	19	Evidence of recent climate change and its attribution to human activities		
	20	Mitigation and adaptation strategies for addressing human-induced climate change		
	21	Case studies from the world		
	22	Case studies from India		
V	**Open Ended Module**		12	10
	24	Climate change in the geological past. Human impact on the environment. Discussions may be		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "The Earth System" by Lee R. Kump, James F. Kasting, and Robert G. Crane. 2019. Pearson
2. "Principles of Paleoclimatology" by Thomas M. Cronin. 2015. Columbia University Press
3. "Climate Change: A Very Short Introduction" by Mark Maslin. 2014. Oxford University Press
4. "Introduction to Modern Climate Change" by Andrew Dessler and Edward Parson. 2016. Cambridge University Press
5. "The Warming Papers: The Scientific Foundation for the Climate Change Forecast" edited by David Archer and Raymond Pierrehumbert. 2011. Wiley-Blackwell
6. "Geological Methods for Archaeology" by Norman Herz, Ervan G. Garrison, and Theodore E. Bunch.2018. Oxford University Press.

Programme	B. Sc. Geology				
Course Code	GEL8EJ401				
Course Title	**CLIMATOLOGY**				
Type of Course	**Major - Elective**				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Give a brief account of the global climate and the processes associated with it.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Examine general circulation and processes of atmosphere over the globe and key elements of global climate models	An	C	Test Paper
CO2	Analyze global balance of energy and transfer of radiation in the atmosphere	An	C	Assignment
CO3	Compare various process and forms of precipitation and cyclones	An	C	Test Paper
CO4	Conclude the basic concept of latitude, longitude and motions of Earth	Ev	C	Assignment
CO5	Examine the air masses and its classification	An	C	Test Paper
CO6	Discuss the general climate of India	Un	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: CLIMATOLOGY

Module	Unit	Content	Hrs	Marks
I	**Climate Systems**		**10**	
	1	Latitudes & Longitudes - Standard Time, Motions of the earth: Rotation and Revolution,	2	
	2	Milankovitch Cycle	2	
	3	Atmosphere: Role, Structure & Composition Temperature Distribution on Earth	2	**15**
	4	Insolation & Heat Budget,	2	
	5	Geographical distribution of the climatic types – Koppen's and Thornthwaite's classification of climate, Global warming	2	
II	**Wind System**		**15**	
	6	Lapse rate – Atmospheric stability	2	
	7	Latent Heat of Condensation	2	
	8	Atmospheric Pressure Belts and Wind Systems,	3	
	9	Factors Affecting Wind movement, Coriolis Force,	2	**20**
	10	Types of Winds: Permanent, Secondary & Local Winds	2	
	11	Temperature Inversion: Types & Effects on Weather,	2	
	12	Geostrophic Wind, Jet Streams & Rossby Waves, Major Jet Steams: Subtropical Jet Stream & Polar Jet Stream	2	
III	**Clouds**		**10**	
	13	Air Mass - Air masses based on Source Regions, Fronts,	2	
	14	Types of Fronts: Stationary Front, Warm Front, Cold Front & Occluded Front	3	**15**
	15	Humidity: Relative Humidity & Dew point, Condensation Forms of Condensation: Dew, Fog, Frost, Mist	2	
	16	Types of Clouds	3	
IV	**Cyclones**		**13**	
	17	Smog: Photochemical smog & Sulphurous smog	2	
	18	Precipitation: Types of Precipitation, Types of Rainfall	2	
	19	Thunderstorm, Thunder & Lightning, Tornado, Tropical Cyclones: Favourable Conditions for Formation, Stages of Formation & Structure,	2	**20**
	20	Storm Surge, Naming of Cyclones,	2	
	21	Cyclones in Arabian Sea, Bay of Bengal, Temperate Cyclones (Mid Latitude Cyclone or Extra tropical cyclones or Frontal Cyclones)	3	
	22	Droughts	2	
V	**Open Ended Module**		**12**	**10**
		General Weather system in India		
		Climate Change		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Essentials of Meteorology: An Invitation to the Atmosphere" by C. Donald Ahrens. (Cengage Learning, 2016)
2. "Climatology" by Robert V. Rohli and Anthony J. Vega (Jones & Bartlett Learning, 2017)
3. "The Atmosphere: An Introduction to Meteorology" by Frederick K. Lutgens and Edward J. Tarbuck. (Pearson, 2018)
4. "Fundamentals of Weather and Climate" by Robin McIlveen (Oxford University Press, 2010)
5. "Climate and the Oceans" by Geoffrey K. Vallis (Princeton University Press,2012)
6. "Meteorology Today: An Introduction to Weather, Climate, and the Environment" by C. Donald Ahrens and Robert Henson. (Cengage Learning, 2018)
7. "Climate Change: A Very Short Introduction" by Mark Maslin (Oxford University Press, 2021)
8. "Atmospheric Science: An Introductory Survey" by John M. Wallace and Peter V. Hobbs., (Academic Press, 2006)

Programme	B. Sc. Geology				
Course Code	GEL8EJ402				
Course Title	**ENVIRONMENTAL INFORMATICS**				
Type of Course	**Major - Elective**				
Semester	8				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Big data related to environment need to be analysed in order to understand the environment. This course offers a guideline for that purpose.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will be able to collect, store, manage, and analyze environmental data using various informatics tools and databases.	An	C	Test Paper
CO2	Students will demonstrate proficiency in using Geographic Information Systems (GIS) and remote sensing technologies to visualize, analyze, and interpret spatial data related to environmental issues.	An	C	Assignment
CO3	Students will be capable of developing and applying computational models to simulate environmental processes.	An	C	Test Paper
CO4	Students will use statistical and computational methods to analyze environmental data,	Ev	C	Assignment
CO5	Students will integrate knowledge from various disciplines such as ecology, hydrology, geology, and	An	C	Test Paper

	computer science to address complex environmental problems using informatics solutions.			
CO6	Students will be able to effectively communicate the results of their analyses and models to diverse audiences.	Un	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ENVIRONMENTAL INFORMATICS

Module	Unit	Content	Hrs	Marks
I		**Introduction to Environmental Informatics**	**10**	**15**
	1	Overview of Environmental Informatics		
	2	Role of Informatics in Geology and Environmental Science		
	3	Data Sources and Collection Methods		
	4	Data Management and Quality Assurance		
II		**Geospatial Analysis and Modeling**	**14**	**20**
	5	Fundamentals of Geospatial Analysis		
	6	Spatial Data Processing and Analysis		
	7	Spatial Interpolation Techniques		
	8	Geostatistics and Spatial Analysis		
	9	Introduction to Spatial Modeling		
III		**Environmental Data Management and Visualization**	**10**	**15**
	10	Principles of Environmental Data Management		
	11	Database Design and Implementation		
	12	Environmental Data Visualization Techniques		
	13	Geographic Data Visualization		
	14	Time Series Visualization		
	15	Multivariate Data Visualization		
IV		**Environmental Informatics Applications and Case Studies**	**14**	**20**
	16	Environmental Monitoring and Assessment		
	17	Environmental Impact Assessment		
	18	Environmental Risk Analysis		
	19	Decision Support Systems in Environmental Management		
	20	Reports of the Intergovernmental Panel for Climate Change		
	21	Open access data sources related to environment		
	22	Data analysis to understand the environment		
V		**Open Ended Module**	**12**	**10**
		The students may be encouraged to access data freely available and discuss the same.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. Methodology and Applications of Environmental Information Processing" by Vladimir Funtikov (Springer, 2013).
2. "Geographic Information Systems and Science" by Paul A. Longley et al. (Wiley, 2015).
3. "GIS and Geocomputation for Water Resource Science and Engineering" by Barnali Dixon and Venkatesh Uddameri (Wiley, 2016).
4. "Data Visualization: Principles and Practice" by Alexandru C. Telea (AK Peters/CRC Press, 2014).
5. "Visualizing Environmental Science" by Linda R. Berg and David M. Hassenzahl (Wiley, 2015).
6. "Environmental Modeling: Using MATLAB" by Ekkehard Holzbecher (Springer, 2007).
7. "Environmental Modelling: Finding Simplicity in Complexity" by John Wainwright and Mark Mulligan (Wiley, 2013).

Programme	B. Sc. Geology				
Course Code	GEL8EJ403				
Course Title	**REMOTE SENSING FOR GEOLOGY**				
Type of Course	Major - Elective				
Semester	8				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Remote Sensing for Geology is a specialized course designed to introduce undergraduate students to the principles, methods, and applications of remote sensing in geological studies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of remote sensing and its application in geological studies.	An	C	Test Paper
CO2	Identify geological features and structures using remote sensing imagery.	An	P	Assignment
CO3	Analyze spectral signatures and image processing techniques for geological interpretation.	An	C	Test Paper
CO4	Interpret geological processes and landforms from satellite and aerial imagery.	Ev	P	Assignment
CO5	Apply remote sensing data for geological mapping and resource exploration.	An	C	Assignment
CO6	Communicate geological findings effectively through remote sensing data analysis and interpretation.	Un	P	Report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive nowledge (M)

Detailed Syllabus: REMOTE SENSING FOR GEOLOGY

Module	Unit	Content	Hrs	Marks
I	**Introduction to Remote Sensing for Geology**		**10**	**15**
	1	Overview of remote sensing principles and platforms	2	
	2	Electromagnetic spectrum and interaction with Earth's surface	2	
	3	Types of remote sensing sensors	2	
	4	Data acquisition techniques	2	
	5	Applications of remote sensing in geological studies	2	
II	**Image Interpretation and Analysis**		**15**	**20**
	6	Basics of image interpretation and visual analysis	2	
	7	Characteristic features used for visual analysis	2	
	8	Spectral characteristics of geological materials	3	
	9	Image processing techniques - enhancement	2	
	10	Image processing techniques - classification	2	
	11	Image processing techniques - change detection)	2	
	12	Case studies of geological feature identification and mapping	2	
III	**Geological Mapping and Resource Exploration**		**10**	**15**
	13	Geological mapping using remote sensing data	2	
	14	Integration of remote sensing with Geographic Information Systems (GIS)	3	
	15	Applications of remote sensing in mineral and hydrocarbon exploration	2	
	16	Field validation and ground truthing of remote sensing data	3	
IV	**Advanced Remote Sensing Applications in Geology**		**13**	**20**
	17	Hyperspectral remote sensing for mineral mapping and lithological discrimination	2	
	18	Radar remote sensing for terrain analysis and geological hazard assessment	3	
	19	Remote sensing of active tectonics	2	
	20	Remote Sensing in hydrogeological studies	3	
	21	Remote sensing for	3	
	22	Future trends and emerging technologies in remote sensing for geological applications	2	
V	**Open Ended Module**		**12**	**10**
		Case studies of remote sensing in various geological applications. This can be carried out and demonstrated using NRSC, Bhuvan and similar datasets and Open source software.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Remote Sensing and Image Interpretation" by Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman. (Wiley, 2015)
2. "Remote Sensing of the Environment: An Earth Resource Perspective" by John R. Jensen.
   (Pearson, 2015)
3. "Introduction to Remote Sensing" by James B. Campbell
   (Guilford Press ,2015)
4. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods
   (Pearson, 2017)
5. "Remote Sensing for Geologists: A Guide to Image Interpretation" by Gary L. Prost
   (CRC Press, 2009)
6. "Hyperspectral Remote Sensing: Principles and Applications" by Gui-Jun Yang
   (CRC Press, 2012)

Programme	B. Sc. Geology				
Course Code	GEL8EJ404				
Course Title	**OCEANOGRAPHY**				
Type of Course	Major - Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Oceanography is a course designed to introduce students to the study of the Earth's oceans, covering their physical, chemical, geological, and biological characteristics.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental principles of oceanography and its interdisciplinary nature.	U	F	Instructor-created exams / Quiz
CO2	Describe the physical properties of seawater and the processes driving ocean circulation.	An	C	Assignment
CO3	Analyze the geological features and processes shaping the seafloor and continental margins.	An	P	Assignment
CO4	Explain the chemical composition of seawater and the biogeochemical cycles occurring in the oceans.	C	P	Problem Solving
CO5	Evaluate the diversity and distribution of marine life and their adaptation to different oceanic environments.	Ap	P	Test paper
CO6	Apply knowledge of oceanography to interpret environmental issues and their implications for society.	C	P	Assignment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus: OCEANOGRAPHY

Module	Unit	Content	Hrs	Marks
I	**Introduction to Oceanography**		10	15
	1	Overview of oceanography as a scientific discipline		
	2	Historical development of oceanographic research		
	3	Oceanographic tools and methods (ships, satellites, buoys, remote sensing)		
	4	Ocean basins and their physical characteristics		
	5	Oceans and mineral resources		
	6	Oceans and climate		
II	**Physical Oceanography**		6	10
	7	Properties of seawater (temperature, salinity, density)		
	8	Ocean circulation patterns (wind-driven)		
	9	Ocean circulation patterns (thermohaline circulation)		
	10	Waves, tides, and currents		
	11	Concepts of El NiNo & La Nina		
	12	Coastal processes and landforms (waves, beaches, estuaries)		
III	**Chemical and Geological Oceanography**		16	20
	13	Chemical composition of seawater (major ions, nutrients, gases)		
	14	Biogeochemical cycles (carbon, nitrogen, phosphorus)		
	15	Marine sediments and sedimentary processes		
	16	Plate tectonics and marine geology-continental margins		
	17	Plate tectonics and marine geology - mid-ocean ridges		
IV	**Biological Oceanography**		16	25
	18	Marine ecosystems and biodiversity		
	19	Adaptations of marine organisms to different oceanic environments		
	20	Marine food webs and trophic interactions		
	21	Human impacts on marine ecosystems		
	22	Conservation efforts of marine ecosystems		
V		**Open-ended module**	12	10
		Technological advancements in understanding ocean basins could be discussed. Scientific movies may be shown and discussed.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Oceanography: An Invitation to Marine Science" by Tom S. Garrison (Cengage Learning, 2019)
2. "Essentials of Oceanography" by Alan P. Trujillo and Harold V. Thurman (Pearson,2017)
3. "Introduction to the World's Oceans" by Keith A. Sverdrup, Craig F. Bohren, and Alan P. Trujillo. (McGraw-Hill Education, 2019)
4. "Marine Biology: Function, Biodiversity, Ecology" by Jeffrey S. Levinton (Oxford University Press, 2017)
5. "Oceanography and Marine Biology: An Introduction to Marine Science" by David W. Townsend. (Sinauer Associates Inc., 2018)
6. "Marine Geology: Exploring the New Frontiers of the Ocean" by Jon Erickson (CreateSpace Independent Publishing Platform, 2017)

Programme	B. Sc. Geology				
Course Code	GEL8EJ405				
Course Title	**ANALYTICAL TECHNIQUES IN GEOLOGY**				
Type of Course	Major - Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	This course provides a theoretical foundation for understanding analytical techniques commonly used in geological research and exploration. Students will learn the principles behind various analytical methods, including spectroscopy, microscopy, chromatography, and mass spectrometry.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the theoretical principles behind analytical techniques commonly used in geology.	U	F	Test Paper
CO2	Describe the instrumentation and methodologies involved in spectroscopic, microscopic, chromatographic, and mass spectrometric techniques.	An	C	Assignment
CO3	Apply analytical techniques to identify and quantify geological components, minerals, and elements in geological samples.	An	P	Assignment
CO4	Interpret geochemical data obtained from analytical techniques to understand geological processes and environments.	C	P	Problem Solving
CO5	Evaluate the strengths and limitations of different analytical techniques for geological applications.	Ap	P	Test paper
CO6	Communicate effectively about the theory and application of analytical techniques in geological research.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: ANALYTICAL TECHNIQUES IN GEOLOGY

Module	Unit	Content	Hrs	Marks
I	1	Overview of Analytical Techniques	5	8
	2	Importance of Analytical Techniques in Geology		
	3	Principles of Analytical Chemistry		
II	4	Atomic Absorption Spectroscopy (AAS)	15	18
	5	Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)		
	6	X-ray Fluorescence (XRF)		
	7	Fourier Transform Infrared Spectroscopy (FTIR)		
III	8	Optical Microscopy	10	14
	9	Scanning Electron Microscopy (SEM)		
	10	Transmission Electron Microscopy (TEM)		
	11	Atomic Force Microscopy (AFM)		
IV	12	Gas Chromatography (GC)	18	30
	13	Liquid Chromatography (LC)		
	14	High-Performance Liquid Chromatography (HPLC)		
	15	Gas Chromatography-Mass Spectrometry (GC-MS)		
	16	Liquid Chromatography-Mass Spectrometry (LC-MS)		
	17	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)		
	18	Application of Analytical Techniques in Geology		
	19	Interpretation of Geochemical Data		
	20	Interpretation of published data		
	21	Research Applications		
	22	Case Studies		
V	**Open Ended Module**		12	10
	Students may be given exposure to the facilities by visiting laboratories in the same institution or other HEIs or Laboratories.			

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Principles and Applications of Geochemistry" by Gunter Faure., (Pearson, 1998)
2. "Introduction to Mineralogy and Petrology" by Swapan Kumar Haldar., (Elsevier, 2013)
3. "Geochemical Instrumentation and Analysis" by Michael W. A. Dixon and Roy W. Haggerty., (Cambridge University Press, 2014)
4. "Modern Analytical Geochemistry: An Introduction to Quantitative Chemical Analysis Techniques for Earth, Environmental and Materials Scientists" edited by Robin Gill (Routledge, 1997)
5. "Handbook of Practical X-Ray Fluorescence Analysis" by Burkhard Beckhoff, Birgit Kanngießer, Norbert Langhoff, Reiner Wedell, and Helmut Wolff., (Springer, 2006)
6. "Essentials of Igneous and Metamorphic Petrology" by B. Ronald Frost and Carol D. Frost., (Cambridge University Press, 2013)
7. "X-Ray Diffraction: A Practical Approach" by C. Suryanarayana and M. Grant Norton (Springer,1998)
8. "Principles of Stable Isotope Geochemistry" by Zachary Sharp.,(Pearson, 2006)

Programme	B. Sc. Geology				
Course Code	GEL8EJ406				
Course Title	**INTRODUCTION TO SOIL SCIENCE**				
Type of Course	Major - Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	Introduction to Soil Science is designed to provide students with a comprehensive understanding of soil properties, formation, classification, and their significance in various fields.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts and principles of soil science.	U	F	Instructor-created exams / Quiz
CO2	Describe the physical, chemical, and biological properties of soil.	An	C	Assignment
CO3	Identify the different components of soil and their roles in soil formation.	An	P	Assignment
CO4	Analyze soil profiles and classify soils based on recognized systems.	C	P	Problem Solving
CO5	Evaluate the importance of soil in supporting ecosystem services.	Ap	P	Test paper
CO6	Apply knowledge of soil science principles to address environmental, and land management challenges.	C	P	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: INTRODUCTION TO SOIL SCIENCE

Module	Unit	Content	Hrs (60)	Marks (70)
I	**Introduction to Soil Science**		**8**	
	1	Definition and scope of soil science	2	
	2	Historical development of soil science	2	**10**
	3	Importance of soil in ecosystems and human society	2	
	4	Soil science research methods and techniques	2	
II	**Soil Formation and Classification**		**12**	
	5	Factors influencing soil formation (parent material, climate, organisms, topography, time)	2	
	6	Soil formation processes (weathering, erosion, deposition)	2	
	7	Soil profile and horizons	2	**10**
	8	Soil classification systems (e.g., USDA Soil Taxonomy, World Reference Base for Soil Resources)	4	
III	**Physical & Chemical Properties of Soil**		**18**	
	9	Soil texture and particle size distribution	2	
	10	Soil structure and aggregation	2	
	11	Soil porosity and permeability	2	
	12	Soil temperature, color, and density	2	**20**
	13	Soil composition and mineralogy	3	
	14	Soil pH and acidity/alkalinity	2	
	15	Soil nutrients and nutrient cycling (nitrogen, phosphorus, potassium)	3	
	16	Cation exchange capacity and soil fertility	2	
IV	**Biological Properties of Soil**		**10**	
	17	Soil microorganisms (bacteria, fungi, protozoa)	2	
	18	Soil fauna (earthworms, nematodes, arthropods)	2	**20**
	19	Soil organic matter and decomposition processes	3	
	20	Soil biodiversity and its importance in ecosystem functioning	3	
V	**Open Ended Module**		**12**	**10**
		Soil science and its close relation to geology may be thoroughly discussed.		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	5
2	Seminar/ Viva/ Quiz/ Data Collection	6	3
3	Assignment/ Report Writing	4	2

Mapping of COs to Assessment Rubrics:

	Instructor-Created Exams / Quiz	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓		✓
CO 4		✓	
CO 5		✓	✓
CO 6		✓	✓

References:

1. "Soil Science: An Introduction to the Properties and Management of New Zealand Soils" by Peter J. Almond and Douglas S. Hamilton., (Oxford University Press, 2014)
2. "Soil Science Simplified" by Helmut Kohnke and Pan Ming Huang (Waveland Press, 1997)
3. "The Nature and Properties of Soils" by Nyle C. Brady and Ray R. Weil (Pearson, 2016)
4. "Principles of Soil Chemistry" by Kim H. Tan., (CRC Press, 2011)
5. "Soil Science: Step-by-Step Field Analysis" by P.D. Sharma (Daya Publishing House, 2010)
6. "Introduction to Environmental Soil Physics" by Daniel Hillel (Academic Press, 2003)

Research Methodology Course in Geology

Programme	B. Sc. Geology				
Course Code	GEL8CJ489				
Course Title	**RESEARCH METHODOLOGY IN GEOLOGY**				
Type of Course	Major				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	NIL				
Course Summary	The course introduces the research methodology in Geology to the students who are opting Honours with Research Programme in Geology				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop clear and concise research questions and hypotheses based on existing literature and geological concepts.	U	F	Exam
CO2	Plan and design geological research projects, including the selection of appropriate methodologies and tools.	Ap	C	Quiz
CO3	Employ various data collection techniques, such as field sampling, laboratory analysis, and remote sensing.	An	P	Assignment
CO4	Synthesize and integrate data from multiple sources to draw comprehensive geological conclusions.	E	M	Viva
CO5	Conduct thorough literature reviews to support research hypotheses and contextualize findings.	Ap	F	Assignment
CO6	Write clear and well-structured research papers and reports following scientific conventions.	E	M	Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: RESEARCH METHODOLOGY IN GEOLOGY

Module	Unit	Content	Hrs	Marks
I	**Introduction to Research Methodology in Geology**		**12**	**20**
	1	Overview of scientific research methods		
	2	Importance of research in geology		
	3	Ethical considerations in geological research		
	4	Identifying research gaps and questions		
	5	Developing testable hypotheses		
II	**Research Design and Data Collection Techniques**		**12**	**15**
	6	Types of research designs (experimental, observational, etc.)		
	7	Project planning and management		
	8	Field methods: sampling, mapping, surveying		
	9	Laboratory methods: mineral and rock analysis, geochemical methods		
	10	Remote sensing and GIS applications		
III	**Data Analysis Methods**		**12**	**20**
	11	Statistical analysis in geology		
	12	Software tools for data analysis (e.g., Excel, R, ArcGIS)		
	13	Introduction to computational modeling		
	14	Integrating multiple data sources		
	15	Using geological software for data visualization		
IV	**Critical Evaluation of Literature**		**12**	**15**
	16	Conducting literature reviews		
	17	Assessing the quality and reliability of sources		
	18	Synthesizing literature to support research		
	19	Writing research papers and reports		
V	**Open – Ended Module**		**12**	**10**
		Preparing and delivering oral presentations. Designing posters and visual aids		

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-							
CO 2	2	3	-	-	-	-							
CO 3	-	-	1	-	-	-							
CO 4	-	-	2	3	-	-							
CO 5	-	1	-	-	-	-							
CO 6	-	-	-	3	-	-							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

External evaluation: 70 marks. Internal Evaluation: 30 marks

INTERNAL MARK SPLIT-UP (TOTAL 30 MARKS)			
	Components of Internal Evaluation	**4 Theory Modules (20)**	**Open ended Module (10)**
1	Test paper/ Mid semester Exam	10	4
2	Seminar/ Viva/ Quiz	6	4
3	Assignment	4	2

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar	End Semester Examinations
CO 1			✓
CO 2	✓		
CO 3	✓		
CO 4		✓	✓
CO 5			
CO 6			✓

References:

1. "Research Methods in Geomorphology" by Ronald G. Barry, Taylor & Francis. (1998)
2. "Research Methods in Physical Geography" by Basil Gomez and John Paul Jones III Wiley-Blackwell. (2010)
3. "Geological Field Techniques" by Angela L. Coe. Wiley-Blackwell. (2010)
4. "Data Analysis in the Earth Sciences Using Matlab" by Gerald B. Fogelson Cambridge University Press. (1997)
5. "Introduction to Geological Data Analysis" by Andrew Curtis and Roger Wood Cambridge University Press. (2004)
6. "Geostatistics Explained: An Introductory Guide for Earth Scientists" by Steve McKillup and Melinda Darby Dyar. Cambridge University Press. (2010)

Format of the Question Paper Type I for Major and Minor Courses

I Semester B.Sc. (CUFYUGP) Degree Examinations October 2024
GEL1CJ101: Introduction to Geology
(Credits: 4)

Maximum Time: 2hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain the significance of plate tectonics in scientific inquiry.
2. Describe the primary layers of Earth's internal structure.
3. What is the rock cycle and why is it important in geology?
4. Define radiometric dating and its role in geochronology.
5. What are the main components of Earth's spheres?
6. Outline the main steps involved in the scientific method.
7. Describe the major types of volcanic landforms.
8. Explain the process of mountain building.
9. What are seismic waves and how are they used to study earthquakes?
10. Discuss the impact of volcanic hazards on human activity.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss the development of geology as a scientific discipline and its historical milestones.
12. Explain the formation of Earth's layered structure and its significance.
13. Analyze the relationship between plate tectonics and the formation of major geological features.
14. Describe the process of absolute (radiometric) dating and its importance in constructing the Geological Time Scale.
15. Evaluate the role of Earth's internal structure in understanding seismic activity and earthquake prediction.
16. Examine the major geological events that define the different eras, periods, and epochs of Earth's history.
17. Discuss the nature of volcanic eruptions and the different types of products they produce.
18. Assess the methods used for earthquake prediction, forecast, and mitigation, and their effectiveness.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Discuss the evolution of Earth from its formation to the present day, highlighting the key processes and events that have shaped its geological history.
20. Evaluate the application of various dating methods in geology and their contribution to the construction of the Geological Time Scale, including an overview of major geological eras, periods, and epochs.

Format of the Question Paper Type II for General Foundation Courses

I Semester B.Sc. (CUFYUGP) Degree Examinations October 2024
GEL1FM105: EXPLORING THE MOTHER EARTH
(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A
[Answer All. Each question carries 2 marks] (Ceiling: 16 Marks)

1. Define physical geology and historical geology.
2. What are the main layers of Earth's structure?
3. Describe the three main types of rocks in the rock cycle.
4. Summarize the Nebular Hypothesis for the origin of the Solar System.
5. What are Earth's spheres and their significance?
6. Explain the principle of stratigraphy in relative dating.
7. What is radiometric dating and how does it work?
8. Describe the main processes involved in weathering and erosion.
9. What are the different types of plate boundaries?
10. Outline the key features of divergent plate boundaries.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Discuss the differentiation of Earth's interior and the formation of its core, mantle, and crust.
12. Explain the significance of the geological time scale and how it is divided into eons, eras, periods, and epochs.
13. Analyze the role of tectonic activity in shaping major landforms such as mountains and valleys.
14. Evaluate the evidence supporting the theory of plate tectonics and its historical development.
15. Discuss the geological features associated with subduction zones and their impact on Earth's surface.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

16. Discuss the early conditions of Earth during the Hadean, Archean, and Proterozoic eons, and how these conditions influenced the differentiation and development of Earth's layers.
17. Evaluate the processes and methods used in both relative and absolute dating to construct the geological time scale, and discuss the significance of major geological events and landforms within this framework.