PERIYAR UNIVERSITY

NAAC 'A++' Grade - State University - NIRF Rank 56 - State Public University Rank-25

SALEM - 636 011, TAMIL NADU

DEPARTMENT OF GEOLOGY

DST-FIST Sponsored Department

M.Sc., Geology

Choice Based Credit System - CBCS

Effective from the Academic year 2025-2026 onwards and thereafter

JULY 2025

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DEPARTMENT OF GEOLOGY

Programme: M.Sc., GEOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)

Programme code: 514, Duration: 2 Years

TANSCHE -SYLLABUS

REGULATIONS

I. About the Programme

Periyar University offers M.Sc., Geology programme, under Choice Based Credit System (CBCS). The CBCS enables the students to select choice of subjects as per her /his interest and requirement. Acquiring knowledge in the related discipline is advantageous to the students. The CBCS programme is framed in such a way that to impart more Knowledge in the field of Geological sciences.

Geology is an inter-disciplinary subject which enables to understand the earth processes and its treasures. It incorporates inputs from almost all science disciplines. Geologists are mainly involved in the exploration and extraction of natural resources viz., minerals, rocks, fossil fuel and water. As it is a fast growing area geologists will have to play a vital role in building the nation. They can also engage in geological research, which has immense potential in the current scenario.

II. Programme Educational Objectives (PEOs)

PEO1: To demonstrate an understanding of the fundamental principles, concepts in theoretical and practical knowledge of the geological Science.

PEO2: Ability to recognize, evaluate, interpret, and understand issues and opportunities at the frontiers of geological domain.

PEO3: Ability to apply the basic knowledge of geology to real-life problems besides the use of computational and mathematical knowledge and tools.

PEO4: Work ethically and professionally alone and as part of a team, complying with applicable legislation and managing time and other resources efficiently and effectively and manage, execute their geological plans to meet desired goals realistic constraints.

PEO5: Communicate geological information concisely and accurately using written, visual, and verbal means appropriate to the situation.

III. Programme Outcomes (POs)

PO1: Problem Solving Skill

Apply knowledge and skills to solve geological problems.

PO2: Decision Making Skill

Foster analytical and critical thinking abilities for decision-making in sustainable development and use of earth resources.

PO3: Ethical Value

Ability to incorporate quality, ethical and legal value-based perspectives on all geological activities.

PO4: Communication Skill

Ability to develop communication skills in describing the geological problems and resolving it.

PO5: Individual and Team Leadership Skill

Capability to lead themselves and the team to achieve the goals of the organization.

PO6: Employability Skill

Inculcate and enhance employability skills in the global competitive environment.

PO7: Entrepreneurial Skill

Equip with skills and competencies to become an entrepreneur.

PO8: Contribution to Society

Succeed in career endeavors and contribute significantly to society.

PO9: Multicultural competence

Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

PO10: Moral and ethical awareness/reasoning

Ability to embrace moral/ethical values in conducting one's life

IV. Programme Specific Outcomes (PSOs)

PSO1: Placement

To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.

PSO2: Entrepreneur

To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

PSO3: Research and Development

Design, practice and promote Research and Development (R & D) that comply with employment opportunities, leading towards the growth and development of organization.

PSO4: Contribution to Business World

To produce employable, ethical and innovative professionals to sustain in the dynamic business world.

PSO5: Contribution to the Society

To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Note: Cognitive level, K1- Remembering; K2- Understanding; K3- Applying

V. Eligibility for Admission

A candidate who has passed B.Sc. degree in Applied Geology/Geology of this university or an examination of any other university accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc., Geology Degree examinations of this university after a course of two academic years, in the Department of Geology, Periyar University.

VI. Duration of the Programme

The course for the degree of Master of Science in Geology shall consist of two academic years divided into four semesters. Each Semester consists of 90 working days.

VII. List of Courses and Template for P.G., Programmes

Sem. I	Credit	Hrs.	Sem. II	Credit	Hrs.	Sem. III	Credit	Hrs.	Sem. IV	Credit	Hrs.
1.1. Core-I	4	5	2.1. Core-V	4	6	3.1. Core-VIII	4	5	4.1. Core-XII	4	5
1.2 Core-II	4	5	2.2 Core-VI	4	6	3.2 Core-IX	4	5	4.2 Core-XIII	4	5
1.3 Core - III	4	5	2.3 Core- VII	4	6	3.3 Core - X	4	4	4.3 Practical IV	3	6
1.4 Core - IV	4	5	2.4 Compulsory Course	1	6	3.4 Core - XI	4	4	4.4 Project with Viva-Voce	7	10
1.5 Practical I	3	6	2.5 Practical-II	3	4	3.5 Practical III	3	6	4.5 Elective-IV	3	4
1.6 Elective-I:	3	4	2.6 Elective-II	3	2	3.6 Elective - III	3	4	4.6 Skill Enhancement course -II	2	
1.7 Extension Activity	1		2.7 NME-I (Or) SEC	2	**	3.7 Value Added (VA) Courses	2				
						3.8 NME II	2	2			
						3.9 Internship/ Industrial Activity	2	*			
	23	**30**		**21**	**30**		**28**	**30**		**23**	**30**
Total Credit Points – 95											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for all Post - Graduate Courses including Lab Hours.

First Year

Semester - I

Part	List of Courses	Credits	No. of Hours
	Core – I	4	5
	Core – II	4	5
	Core – III	4	5
	Core – IV	4	5
	Practical – I	3	6
	Elective – I	3	4
	Extension Activity	1	*
		23	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – V	4	6
	Core – VI	4	6
	Core – VII	4	6
	Practical – II	3	6
	Elective – II	3	4
	Compulsory Course	1	2
	NME I- SWAYAM/ MOOC (Or) Skill Enhancement Course- I	2	**
		21	**30**

Second Year

Semester - III

Part	List of Courses	Credits	No. of Hours
	Core – VIII	4	5
	Core – IX	4	5
	Core – X	4	4
	Core – XI	4	4
	Practical-III	3	6
	Elective – III	3	4
	Value Added (VA) Courses	2	*
	NME - II	2	2
	Internship / Industrial Activity [Credits]	2	*
		28	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XII	4	5
	Core – XIII	4	5
	Practical-IV	3	6
	Project with VIVA VOCE	7	10
	Elective – IV	3	4
	Skill Enhancement Course –II	2	**
		23	**30**

M.Sc., Geology Programme Structure and Scheme for the Students Admitted in the Year 2025-2026 onwards

Semester	Course Code	Title of the Courses	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
I	25UPGEO1C01	Physical Geology and Geomorphology	4	5	25	75	100
	25UPGEO1C02	Mineralogy and Instrumentation Techniques	4	5	25	75	100
	25UPGEO1C03	Recent Trends in Paleontology	4	5	25	75	100
	25UPGEO1C04	Structural Geology and Geotectonics	4	5	25	75	100
	25UPGEO1L01	Practical-I: Structural Geology, Mineralogy and Paleontology	3	6	40	60	100
	25UPGEO1E01 25UPGEO1E02	Elective Course: Geo-statistics (Or) Geo-heritage and Geo-tourism	3	4	25	75	100
	25UPGEO1X01	Geological Mapping and Field Training - Extension Activity*	1	*	Highly Commended / Commended		
		Total	**23**	**30**	**165**	**435**	**600**
II	25UPGEO1C05	Stratigraphy of India and Its Application	4	6	25	75	100
	25UPGEO1C06	Igneous and Metamorphic Petrology	4	6	25	75	100
	25UPGEO1C07	Sedimentary Geology	4	6	25	75	100
	25UPGEO1L02	Practical-II: Igneous & Metamorphic Petrology and Sedimentary Geology	3	6	40	60	100
	25UPGEO1E03 25UPGEO1E04	Elective Course: Marine Geology (Or) Environmental Earth Science	3	4	25	75	100
	25UPPGC1H01	Fundamental of Human Rights***	1	2	25	75	100
	25UPGEO1N01 (Or) 25UPGEO1N02	NME-I, Online Course - SWAYAM / MOOC ** (Or) #Skill Enhancement Course (SEC-I): Gemmology	2	**	00	100	100
		Total	**21**	**30**	**165**	**535**	**700**
III	25UPGEO1C08	Economic Geology	4	5	25	75	100
	25UPGEO1C09	Applied Micropaleontology	4	5	25	75	100
	25UPGEO1C10	Hydrogeology	4	4	25	75	100
	25UPGEO1C11	Applied Remote Sensing and GIS	4	4	25	75	100
	25UPGEO1L03	Practical-III: Economic Geology, Micropaleontology and Hydrogeology	3	6	40	60	100
	25UPGEO1E05 25UPGEO1E06	Elective Course: Fuel Geology (Or) Isotope Geology	3	4	25	75	100
	25UPGEO1N__	NME-II Supportive Courses	2	2	25	75	100
	25UPGEO1VA1	Value Added (VA) Courses : Peace Education***	2	*	25	75	100
	25UPGEO1I01	Internship / Industrial Activity (During Vacation at the end of First Year)*	2	*	Highly Commended / Commended		
		Total	**28**	**30**	**215**	**585**	**800**
IV	25UPGEO1C12	Exploration Geology	4	5	25	75	100
	25UPGEO1C13	Mining and Engineering Geology	4	5	25	75	100
	25UPGEO1L04	Practical-IV: Remote Sensing & GIS, Exploration Geology and Mining Geology	3	6	40	60	100
	25UPGEO1P01	Project with Viva – Voce	7	10	50	150	200
	25UPGEO1E07 25UPGEO1E08	Elective Course: Oceanography and Climatology (Or) Petroleum Exploration	3	4	25	75	100
	25UPGEO1N03 25UPGEO1N04	Skill Enhancement Course (SEC-II): Disaster Management (Or) Mud Logging	2	**	00	100	100
		Total	**23**	**30**	**165**	**535**	**700**
		Grand Total	**95**	**120**	**710**	**2085**	**2800**

Note: UP - University Programme, GEO1- Geology Programme, C - Core Course, E - Elective Course, L - Laboratory Practical, P - Project, N - Non Major Elective. X* - Extension Activities (Geological Mapping and Field Training for 7 - 10 days/60 hours), I* - Internship (15 days); S** - SWAYAM / MOOC Course Or #Skill Enhancement Course may be opted for those who have not completed SWAYAM / MOOC Courses before III semester; H - Fundamentals of Human Rights***, Value Added (VA) Courses: Peace Education*** (Compulsory).

Credits for M.Sc., Geology Programme	
Core Courses	13 X 4 = 52
Core Laboratory Practical	4 X 3 = 12
Core Project	1 X 7 = 7
Elective Courses	4 X 3 = 12
Non- Major Elective (NME) Courses	2 X 2 = 4
Fundamental of Human Rights	1 X 1 = 1
Skill Enhancement Courses	1 X 2 = 2
Value Added (VA) Courses: Pease Education	1 X 2 = 2
Internship	1 X 2 = 2
Geological Mapping and Field Training	1 X 1 = 1
Total Credits	**95**

Elective Courses (Including Discipline Centric, Generic, Industry / Entrepreneurship)

Sl. No.	Course Code	Title of the Course work	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
I	25UPGEO1E01	Geo-statistics	3	4	25	75	100
II	25UPGEO1E02	Geo-heritage and Geo-tourism	3	4	25	75	100
III	25UPGEO1E03	Marine Geology	3	4	25	75	100
IV	25UPGEO1E04	Environmental Earth Science	3	4	25	75	100
V	25UPGEO1E05	Fuel Geology	3	4	25	75	100
VI	25UPGEO1E06	Isotope Geology	3	4	25	75	100
VII	25UPGEO1E07	Oceanography and Climatology	3	4	25	75	100
VIII	25UPGEO1E08	Petroleum Exploration	3	4	25	75	100

Non-Major Elective (NME- I): SWAYAM / MOOC Courses; Skill Enhancement Courses (SEC); (Semester II & IV)

Sl. No.	Course Code	Title of the Course work	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
01	25UPGEO1N01	Courses of SWAYAM / MOOC (OR)	2	**	00	100	100
02	25UPGEO1N02	Gemmology	2	**	00	100	100
03	25UPGEO1N03	Disaster Management (OR)	2	**	00	100	100
04	25UPGEO1N04	Mud Logging	2	**	00	100	100

Non-Major Elective (NME-II): Offered to Other Departments of Periyar University (Semester III)

Sl. No.	Course Code	Title of the Course work	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
1	25UPGEO1N05	Earth and Environment	2	4	25	75	100
2	25UPGEO1N06	Water Resources Management	2	4	25	75	100
3	25UPGEO1N07	Rain Water Harvesting and Artificial Groundwater Recharge	2	4	25	75	100
4	25UPGEO1N08	Geohazards	2	4	25	75	100

Value Added (VA) Courses – (Semester III & IV)

Sl. No.	Course Code	Title of the Course work	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
1	25UPGEO1VA1	Peace Education***	2	***	25	75	100
2	25UPGEO1VA2	Hydrology and Water Management (Or)	2	30	25	75	100
3	25UPGEO1VA3	Environmental Studies and Earth Sciences	2	30	25	75	100

Add On (AO) Courses (Semester IV)

Sl. No.	Course Code	Title of the Course work	Credits	Hrs.	Int. Marks	Ext. Marks	Total Marks
1	25UPGEO1AO1	Medical Geology	2	30	25	75	100
2	25UPGEO1AO2	Petroleum Geology	2	30	25	75	100
3	25UPGEO1AO3	Groundwater Exploration	2	30	25	75	100

Extra Credits	
Credits for Value Added Courses	2 x 2 = 4
Credits for Add on Courses	3 x 2 = 6
Total Credits	**10**

VIII. Semester

An academic year consists of two semesters. The Normal semester periods are

- Odd Semester: July to November
- Even Semester: December to April

Each semester has 18 teaching weeks with working hours spread over 5 days a week.

IX. Teaching Methodologies

The classroom teaching would be through conventional lectures and use of power point presentation and field demonstration. The lecture would be such that the student should participate actively in the discussion. The Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments/exercise followed by demonstration and finally the students have to do the experiments individually. Periodic tests are conducted for the students, In the case of slow learners; they will be given special attention.

X. Course Components Core courses

Core courses are compulsory basic subjects in the Programme offered by the department. Each core course carries 4 credits. Core courses offered by one department will not be treated as elective by other. Core courses include theory, practical, project work, geological mapping, internship, training, field training and industrial visits. Students can be permitted to carry out project works at reputed institutions and industries.

Elective courses

Elective courses (disciplinary) are offered by the parent department. Each elective course carries 4 credits.

Soft Skills

Soft Skill is aimed at bridging the gap in the curricula and to learn the advancements in other disciplines. The department, in consultation with other departments, will offer supportive courses during III semester. Similarly, students from Geology Department will study the supportive course from other department.

Compulsory Courses

i. Fundamentals of Human Rights ii. Peace Education.

XI. SWAYAM Courses

Massive Open Online Course (MOOC) introduced to the students to help them compare their course content with that of the eminent faculty across the country. MOOC online course is available in the SWAYAM and SWAYAM PRABHA MHRD web portal. All the master level students must enroll and complete two MOOC courses related to their discipline of study.

XV. Extension Activities (Field Work/Training)

Geological field mapping and field training is included in the first semester and its participation is a mandatory requirement. The training is to be scheduled in a single batch for duration of maximum 15 days. It may be guided by faculty members in any place which is geologically significant region within India. Alternatively, the student may be attached to an organization engaged in geological field work (E.g. Geological Survey of India) for imparting training.

XIII. Credits

The quantum of syllabus for various Programmes in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The minimum requirement for a two-year Master's Programme shall be 95 credits.

XIV. Course weightage

A course carrying one credit for lectures will have instruction of one period per week during the semester. If four hours of lecture are necessary in each week for that course, then 4 credits will be the weighted. Thus, normally in each of the courses, credits will be assigned on the basis of the lectures/ tutorials/ laboratory work and other forms of learning in an 18- week schedule.

XV. Evaluation

Evaluation will be done on a continuous basis during the course work through class test and midterm exams. Evaluation may be done by objective type questions, short answers, essays or a combination of these, but the end semester examination is a written examination.

XVI. Attendance

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

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

XVII. Examinations

There shall be four examinations, each at the end of the semester. Candidates failing in any subject/ subjects will be permitted to re-appear for subsequent semesters as per University norms. The practical examinations will be conducted at the end of the I, II, III and IV semesters. Candidates failing in any of the practical examination / examinations will be permitted to appear for such failed practical examination/ examinations at corresponding subsequent practical examinations.

XVIII. Scheme of Examination

Scheme of examination will be followed as per TANSCHE direction.

XIX. Passing Minimum

A candidate has to secure a minimum of 50% mark in each course and earn a minimum of 95 credits for the award of a Master's degree.

XX. Distribution of Marks

Theory

University Examination (External)	: 75 marks
Internal Assessment	: 25 marks

Distribution of Internal Assessment mark

Test	: 10 marks
Attendance	: 5 marks
Assignment	: 5 marks
Seminar	: 5 marks
Total Marks	**25 Marks**

Passing Minimum: Internal Assessment	: No Minimum for Internal assessment
Passing Minimum: External Assessment	: **38 marks (50%) - Mandatory**
Total Passing Minimum	: **50 marks**
Practical Internal Assessment	: No Minimum for Internal assessment
University Examination (External)	: 60 marks

XXI. Calculation of Internal Assessment mark

Attendance	: 05 marks
Practical Record Notes	: 10 marks
Practical Test	: 10 marks
Geological Field Work and Report	: 15 marks
Total Marks	**40 Marks**

Passing Minimum: Internal Assessment	: 20 marks (50%)
Passing Minimum: External Assessment	: 30 marks (50%)
Total Passing Minimum	**: 50 Marks**

Everything should be supported by proper record separate passing minimum is necessary for Internal and External.

XXII. Project/Dissertation

The student should undertake an individual project work during fourth semester under the guidance and supervision of a faculty. A faculty member may supervise the work of more than one student in related fields of study in adjacent field areas, but should be separate on topics. He / she should choose a topic within the purview of the course curriculum. The work can be done in collaboration with the scientific research institutes / establishment / academic institutions on cooperating co-guides from that organization.

The student should submit a thesis (certified as authentic and bonafide by both supervising teacher and Head of the Department) prior to attending Viva-voce. The work done should be presented before the examiners and part of Viva-voce. Submission of thesis prior to viva- voce and presentation during it are mandatory requirements, without which course will be incomplete. If the candidate failed to attend the Viva-voce, they are permitted to appear at the subsequent viva-voce examination.

Project Evaluation:

Internal Assessment	: 50 marks
Report Evaluation	: 50 marks
Viva -Voce Examination	: 100 marks
Total Marks	**200 Marks**

XXIII. Question Paper Pattern

Time: 3 Hours **Max. Marks: 75**

PART- A
Objective Type: 20 x 1=20
(Answer all questions)
(Four questions from each unit)

PART-B
Analytical Type: 3 x 5=15
(Answer any three questions)
(One question from each unit)

PART- C
Descriptive Type: 5 x 8=40
(Answer all questions)
(One question from each unit with either or type)

XXIV. Syllabus

FIRST YEAR

Semester - I

Physical Geology and Geomorphology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C01	Physical Geology and Geomorphology	Core	Y	-	-	-	4	5	25	75	100

Course Objectives	
CO1	To interpret natural processes which act on the Earth's surface and the landforms
CO2	To recognize the types of landforms and quaternary landscapes
CO3	To employ geomorphological studies for structural and mineral exploration
CO4	To understand the pedogenic and geomorphic process for environmental assessment
CO5	To identify different processes involved in regional geological evolution

UNIT	Details	No. of Hrs.	Course Objectives
I	Earth and its internal structure, composition, size and shape. An overview of plate tectonics including elementary concepts of plates, lithosphere, asthenosphere, types of plate boundaries and associated important geological features - oceanic trenches, volcanic arcs, accretionary wedges, topography of mid-ocean ridges and transform faults.	12	CO1
II	Concepts of geomorphology and their developmental stages. Intrinsic and extrinsic driving forces of landform development. Landforms in relation to climate, lithology, and structure. Seismic belts of the earth. Seismicity at plate boundaries.	12	CO2
III	Geomorphic Processes erosion, transportation and deposition - Geomorphic Agents: - Volcanism, Gravity, glaciers, wind, rivers, tides, waves, currents, organisms. Weathering and its types, Pedogenesis, Mass movement.	12	CO3
IV	An overview and types of landforms originated by gravity/structure, fluvial, glacial, aeolian, coastal, volcanoes and karst processes.	12	CO4
V	Quaternary landscapes. Major geomorphic features of India: Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands and deltas.	12	CO5
	Total	**60**	

Text Books

1. Holmes, D.L., (1981). Principles of Physical Geology. ELBS Edition.
2. Pethick, J., (1984). An Introduction to Coastal Geomorphology. Arnold, London.
3. Thornbury., W.D. (1969). Principles of Geomorphology. Wiley Eastern Ltd.
4. Richar Huggett., (2023). Fundamentals of Geomorphology, 5th Edition.
5. Strahler, A.N., (1952). Physical Geology. John Wiley & Sons Inc., New York.

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

1. Bloom. A. L., (1992). Surface of the Earth, Prentice Hall India, New Delhi.
2. Gass, I.G., Smith, P.S & Wilson, R.C.L., (1972). Understanding the Earth, The English Language Books Society, London 2nd Edition.
3. Holmes. A., (1972). Principles of Physical Geology, the English Language Book Society

	and Nelson.
4.	Jacob. J., Russel, R.D & Wilson, J.T., (1959). Physics and Geology, McGraw—Hill, New York.
5.	Leopo1d, L.S., Wolman, K & Miller, J.P., (1970). Fluvial processes in Geomorphology, Eurasia Publishing House Pvt Ltd., New Delhi.
6.	Richard Huggett, (2007). Fundamentals of Geomorphology. 2nd Edition.
7.	Robert, S.A. and Suzanne, P.A.,(2010). Geomorphology—The mechanics and chemistry of landscapes. Cambridge University Press.
8.	Routledge N. Y. Ritter, D.F., Kochel, R.C.,Miller, J.R.,(2002). Process Geomorphology, Wavel and press.
9.	Sagan, C., (1973). Planetary Engineering on Mars, Icarus, 20,513.
10.	Ramkumar, M., (2009). Geological hazards: Causes, Consequences and methods of Containment. New India Publishers, New Delhi.
11.	Sharma, H.S., (1990). Indian Geomorphology. Concept Pub. Co., New Delhi.
12.	Thornbury, W.D., (2004). Principles of Geomorphology. Wiley Eastern Ltd. New Delhi. 2nd Edition.
13.	Wyllie, P.J, (1971). Dynamic Earth, John Wiley & sons, New York.
Web Resources	
1.	https://journals.sagepub.com/home/jom
2.	https://www.americangeosciences.org/
3.	https://www.egu.eu/
4.	https://www.geosociety.org/

Course Outcomes

CO1: Basic knowledge about the internal structure of the Earth.
CO2: Understand the plate tectonics theory and its local-global scale implications.
CO3: Get knowledge about the Landforms: Exogenic and endogenic processes.
CO4: Learn the Landform and tectonics, Drainage pattern, sea level change and geomorphic cycle.
CO5: Students can appreciate and realize the basis of Quaternary landscapes.

Mapping with Programme Outcomes

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

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

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

Programme Specific Outcomes

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

Semester - I

Mineralogy and Instrumentation Techniques

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C02	**Mineralogy and Instrumentation Techniques**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives

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

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction to crystallography - Crystal systems Symmetry elements - Isometric, Tetragonal, Orthorhombic, Hexagonal, Monoclinic and Triclinic systems - Normal classes.	12	CO1
II	Stereographic projections - Axial ratio - Zones and zonal symbols Tautozonal faces - Equation to the normal - Napier's Theorem - Tangent relations – Sine or Anharmonic ratio.	12	CO2
III	Description and composition of the following mineral groups: Quartz, Feldspars, Feldspathoids, Micas, Garnets, Olivine, Pyroxenes, Amphiboles, Zeolites and Carbonate minerals.	12	CO3
IV	Introduction to Optical Mineralogy Isotropic minerals under the polarizing microscope. Uniaxial Minerals: birefringence - indicatrix - optic axis. Properties under parallel and cross nicol conditions. Conoscopic study of uniaxial minerals: interference color, figure and optic sign. Biaxial Minerals: birefringence - indicatrix - optic axis. Properties under parallel and cross nicol conditions. Conoscopic study of biaxial minerals: interference color, figure and optic sign. Sign of elongation. Use of accessory plates.	12	CO4
V	Concepts of crystal field theory and mineralogical spectroscopy.Spot tests - Paper chromatography - Nephelometry - Turbidimetry - Spectroscopy - Flame photometry - X-ray spectroscopy – UV spectroscopy - Mass spectroscopy - Accelerated mass spectroscopy.	12	CO5
	Total	**60**	

Text Book

1.	Donald Bloss, F., (1971). Crystallography and Crystal Chemistry - An Introduction published by Holt, Rinehart and Winston, Inc., New York.
2.	William M. Blackburn and William H. Dennen, (1988). Principles of Mineralogy published by WCB Publishers England, 2nd Edition.
3.	Kerr P.F., (1977). Optical Mineralogy, McGraw Hill New York. 4th Edition.
4.	Gribble C.D. & A.J. Hall, A., (1985). Practical Introduction to Optical mineralogy, Springer. London.
5.	Tisljar, S.K. Haldar, Josip (2013). Introduction to mineralogy and petrology. Burlington: Elsevier Science. ISBN 9780124167100.
6.	Berry Mason, (2004). Mineralogy, CBS Publishers, New Delhi.

7.	Dexter Perkins, (2015). Mineralogy, Pearson Education, India.
8.	William E. Ford, (2006). Dana's Textbook of Mineralogy, CBS Publisher & Dist, New Delhi.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Cornelis Klein and Cornelius S. Hurlbut, Jr., (1993). Manual of Mineralogy published by John Wiley & Sons, Inc. Singapore.
2.	Paul F. Kerr, (1967). Optical Mineralogy, John Wiley & Sons, New York.
3.	Wenk, Hans-Rudolf; Bulakh, Andrey, (2016). Minerals: Their Constitution and Origin. Cambridge University Press. ISBN 9781316425282.
4.	Whewell William, (2010). "Book XV. History of Mineralogy". History of the Inductive Sciences: From the Earliest to the Present Times. Cambridge University Press.
Web Resources	
1.	https://mineralogy-ima.org/
2.	https://www.socminpet.it/dwl.php?file=SIMP/GNM/SIMP_ELEM.pdf
3.	https://www.mineralogicalassociation.ca/
4.	https://www.cambridge.org/core/societies/mineralogical-society-of-great-britain-and-ireland
5.	http://www.minsocam.org/

Course Outcomes

CO1: Basic knowledge on crystal structures and bonding and laws

CO2:Student can learn about the Silicate structures and their physical and chemical properties

CO3: Student get knowledge about the description and composition the minerals

CO4: Student gain knowledge on Optical mineralogical studies

CO5: Student apply the instrumentation techniques in mineralogical studies

Mapping with Programme Outcomes

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

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

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

Programme Specific Outcomes

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

Semester-I

Recent Trends in Paleontology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C03	**Recent Trends in Paleontology**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives

CO1	Learn about the origin and evolution of life, understanding species concept, types of fossils and their utility in biozones and types of biozones
CO2	Study of the major events in the history of Precambrian and Phanerozoic life. Use of fossils in paleoclimate and paleobiogeography. Evolutionary history of selected organisms: Plant Fossils, Fishes, Horse, Elephant and Man
CO3	Detailed study about vertebrate paleontology. Detailed understanding on Pre-Tertiary Indian vertebrate occurrence and paleogeography. Siwaliks and the selected mammal phylogeny based on Indian occurrences, Indian hominid occurrence, distribution and importance
CO4	Learn about the morphology, classification, evolutionary trend, composition and structure of shells of selected groups of invertebrate organisms. To explain about geological history, geographical distribution and description of important Genera
CO5	Demonstrating the sampling methods and sample processing techniques of micropaleontology. To know about the application of micropaleontology in hydrocarbon exploration

UNIT	Details	No. of Hrs.	Course Objectives
I	Fossil record and geological time-scale. Principles of evolution. Theories on origin and evolution of life – Phylogenetic and Ontogenic Analysis – Species Concept – Types of Fossils and Types of Species – Palingenesis – Coenogenesis – Proterogenesis - Thanatocoenosis – Biocoenosis – Sidocoenosis –Biomineralisation. Definitions for Species, index fossil, cosmopolitan species, fossil assemblage, fossil diversity, phylogeny. Types of biozones.	12	CO1
II	Functional morphology, evolution and significance of Plant Fossils, Fishes, Horse, Elephant and Man. Taphonomy and environmental factors, Oxygen and Carbon isotope studies of fossils and paleoclimates– Paleobiogeographic Provinces. Trace Fossils – Fossils and their uses – Biometrics – Major events in the history of Precambrian and Phanerozoic life.	12	CO2
III	Vertebrate Paleontology: Succession of vertebrate life through geologic time. Broad classification and study of some characteristic Indian vertebrate genera. Indian pre-Tertiary vertebrate - their distribution and paleogeographic implication; extinction of dinosaurs. Indian Tertiary vertebrate-Siwalik mammals; phylogeny- Equidae and Probiscidae. Indian fossil Hominoides and modern theories regarding human evolution.	12	CO3
IV	Invertebrate Paleontology: an overview Morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms - Porifera, Bryozoa, Mollusca, Brachiopoda. Geological history, geographical distribution and description of important genera of Trilobita, Echinoides, Coelenterata and Graptoloidea.	12	CO4
V	Micropaleontology: Sampling methods and sample processing techniques. Types of microfossils. Calcareous Microfossils - Foraminifera - major morphologic groups; Benthic Foraminifera; depth biotopes, value in	12	CO5

	paleobathymetric determination. Larger foraminifera – their utility in Indian stratigraphy. Planktic foraminifera and calcareous nannofossils. Ostracoda-morphology, paleoecology & geological history. Brief knowledge about Pteropods, Calpionellids, Calcareous algae, Siliceous algae, Radiolaria and Conodonts. Application of micropaleontology in hydrocarbon exploration. Different microfossil groups and their distribution in India.		
	Text Books		
1.	C. Jain and M.S. Anantharaman, (1996). Palaeontology Evolution and animal distribution. Vishal Publications, Jalandhar.		
2.	H. Woods, (1985). Invertebrate Palaeontology, CBS Publishers & Distributors, New Delhi.		
3.	Agashe, S.N., (1995). Paleo botany, Oxford & IBH. New Delhi.		
4.	Stewart W.N. & G.W., Rothwell, (2005). Palaeobotany, Cambridge University Press.		
5.	Moore R.C. et al., (1952). Invertebrate Fossils, CBS, New Delhi.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Shrock R.R and Twenohofel W.H., (2005). Principles of Invertebrate Palaeontology, CBS Publishers and Distributors, New Delhi.		
2.	Moore R.C, Lalicker C.G and Fisher A.G., (1952). Invertebrate Fossils, McGraw Hill.		
3.	Romer A.S., (1959). The Vertebrate Story, University of Chicago Press, Chicago. 4th Edition		
4.	Nield E.W., and Tucker V.C.T., (1985). Paleontology An Introduction, Pergamon Press, Oxford.		
5.	Colbert, E. H. et al., (2002). Evolution of the Vertebrates, Wiley. New Delhi.		
6.	Arnold. R., (1947). An Introduction to Paleobotany, Mc Graw Hill, New York.		
7.	Arumugam, N., (1989). Organic evolution, Sara Publication, Kanyakumari.		
8.	Benton, M.J. and Harper, D.A.T., (2009). Introduction to Paleobiology and the fossil record, Wiley-Blackwell. London.		
9.	Clarkson E.N.K., (1986). Invertebrate paleontology and evolution. George Allen & Unwin.		
10.	Colbert, E. (1955). The Evolution of Vertebrates, John Wiley, New York.		
11.	Jain, P.C & Anantharaman, M.S., (1996). Palaeontology, Evolution and Animal Distribution, Vishal Publications.		
12.	Murray, J.W., (1985). Atlas of invertebrate macrofossils, Longman, London.		
13.	Raup D.M. & Stanley (1985). Principles of paleontology, CBS Publ. & Distributors, New Delhi.		
14.	Swinnerton, H. H., (1961). Outlines of Paleontology, Edward Arnold Publ. Ltd., London.		
Web Resources			
1.	https://en.wikipedia.org/wiki/Age_of_Earth		
2.	https://www.lyellcollection.org/doi/10.1144/GSL.SP.2001.190.01.14.		
3.	https://digitalatlas.cose.isu.edu/geo/basics/fossil.htm		
4.	https://www.sciencedirect.com/topics/immunology-and-microbiology/hemichordata		
5.	https://www.qm.qld.gov.au/Explore/Research/Biodiversity		

Course Outcomes

CO1: Student can understand about the fossil record and geological time-scale

CO2: To get knowledge about the theory and Origin and development and significance of Indian occurrence and distribution

CO3: Students get more knowledge about vertebrate paleontology

CO4: Students get more knowledge about Invertebrate paleontology

CO5: Student gain knowledge on micropaleontology: Sampling methods, sample processing techniques and application in petroleum exploration

Mapping with Programme Outcomes

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

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

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

Programme Specific Outcomes

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

Semester-I

Structural Geology and Geotectonics

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C04	**Structural Geology and Geotectonics**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives

CO1	The student can interpret and evaluate different structures that exist in the earth
CO2	Can critically assess and review the energy needed to cause different structures
CO3	Can describe and explain major and minor structures
CO4	Can understand to compare and contrast structures related to each other
CO5	Can evaluate and explain the causes of different structures

UNIT	Details	No. of Hrs.	Course Objectives
I	Stress and Strain Fundamentals: Theory of stress and strain - Behavior of rocks under stress - Mohr's circle - Various states of stress and their representation by Mohr's circles - Different types of failure and sliding criteria - Geometry and mechanics of fracturing and conditions for re-activation of pre-existing discontinuities, Elastic, brittle, and ductile deformation mechanisms, Paleo-stress analysis - Common types of finite strain - Ellipsoids - L-, L-S-, and S- tectonic fabrics.	12	CO1
II	Deformation Mechanisms and Shear Zones: Techniques of strain analysis - Particle paths and flow patterns - Progressive strain history and methods for its determination. Deformation mechanisms - Role of fluids in deformation processes - Geometry and analysis of brittle-ductile and ductile shear zones - Petrofabric analysis - Field and laboratory techniques - Point and percentage diagrams - Preparation of petrofabric diagrams of quartz, biotite and calcite - Symmetry of fabric - Symmetry of movement.	12	CO2
III	Rotated minerals - Syn-, pre and post-kinematic - Differential movement in rocks using rotated minerals - Oscillatory movements - Characteristics - Neotectonics - Indian and global evidences - Methods of study of neotectonics. Sheath folds - Geometry and mechanics of development of folds - Boudins - Foliation and lineation - Interference patterns and structural analysis in areas of superposed folding - Fault-related folding - Geometry and mechanics of faults - Gravity-induced structures. Structural analysis.	12	CO3
IV	Major tectonic features and associated structures in extensional, compressional, and strike-slip terrains - Joints and unconformities - Penecontemporaneous deformational structures of sedimentary rocks. Plate tectonics - Concept and principles - Continental drift - Geological and geophysical evidences - Mechanics, objections and present status of plate tectonics.	12	CO4
V	Geodynamics and Plate Boundaries; Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains- Geological and geophysical characteristics of plate boundaries - Geodynamic evolution of the Himalayas – Paleo-magnetism - Sea floor spreading and plate tectonics - Island arcs, oceanic islands and	12	CO5

	volcanic arcs - Isostasy, orogeny and epiorogeny - Geodynamic of the Indian Plate.		
	Text Books (Latest Editions)		
1.	Billings, M.P., (2014). *Structural Geology*. Prentice-Hall, Inc., Learning Pvt. Ltd., Delhi. 3rd Edition.		
2.	Beloussov, V.V., (1962). *Basic Problems in Geotectonics*. McGraw-Hill Book Co., New York.		
3	Badgeley, P.C., (1965). *Structural and Tectonic Principles*. Harper & Row Publishers, New York.		
4	Twiss, R.J. and Moores, E.M., (2007). *Structural Geology*. W.H. Freeman and Company, New York. 2nd Edition.		
5	Van der Pluijm, B.A., and Marshak, S., (2004). Earth Structure - An Introduction to Structural Geology and Tectonics, New York: W. W. Norton. 2nd Edition.		
6.	Haakon Fossen, (2010). Structural Geology, Cambridge University Press.		
7	Ramsay. J.G & Huber. M.I, (1983). The Techniques of Modern Structural Geology: Vol. 1 - Strain Analysis.		
8	Ghosh, S.K., (1993). Structural Geology: Fundamentals and Modern Developments. Pergamon Press.		
9	Valdiya, K.S., (2010). Dynamic Himalaya, Universities Press.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Suppe, J., (1985). *Principles of Structural Geology*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: ISBN 0137105002.		
2.	Marshak, S. and Mitra, G., (1988). *Basic Methods of Structural Geology*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: 0130651788.		
3.	King Hubbert, M., (1972). Structural Geology, Hafner Publishing Company.		
4.	Davis G.H. and Reynolds, S.J., (1996). The Structural Geology of Rocks and Regions Wiley. 2nd Edition.		
5.	Passchier, C.W., and Trouw, R.A.J., (1998). Microtectonics, Berlin: Springer.		
Web Resources			
1.	http://www.labotka.net		
2.	http://www.patnasciencecollege.org		
3.	https://geomorphology.org.uk		
4.	https://gradeup.co		
5.	https://www.nps.gov>subjects>gla		

Course Outcomes

CO1: To gain knowledge about the geological structures like fold, fault, unconformity, foliation and lineation and its causes and mechanisms.

CO2: Gain knowledge on techniques of strain analysis.

CO3: Student learn about the Methods of study of neotectonics.

CO4: Student understand on Major tectonic features and associated structures in extensional- compressional- and strike-slip terrains - Joints and unconformities.

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-I

Practical - I: Structural Geology, Mineralogy and Paleontology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1L01	**Structural Geology, Mineralogy and Paleontology**	Core	Y	-	Y	-	3	6	40	60	100

Course Objectives	
CO1	Identify and describe geological structures using geological maps, cross section and field measurements
CO2	The students learn to identify the structure of the geology
CO3	To determination and calculate through different procedures to find out solution of minerals
CO4	To study of common rock forming minerals under petrological microscope
CO5	To recognition of fossils and interpretation of paleoclimate

UNIT	Details	No. of Hrs.	Course Objectives
I	Determination of attitude of beds - Geometrical, graphical and trigonometric projections -Reconstruction of parallel fold and fault - Preparation and analysis of structure contour map. Orthographic projection.	12	CO1
II	Construction of perpendicular and vertical sections of plunging fold. Geochronology - Pi and beta diagrams - Structural complex -Depth to strata - True thickness of beds - Interpretation of geological maps involving normally dipping beds, bore well data. Interpretation of geological maps involving symmetrical and asymmetrical fold, isoclinal fold, recumbent fold, plunging fold, strike fault and step fault.	12	CO2
III	Study of symmetry and forms in the crystal models. X-rays and X-ray refraction, Powder method, Determination of unit cell parameters- Crystal projections -Stereographic projection, Spherical Projection and Gnomonic projection.	12	CO3
IV	Study of common rock forming minerals under petrological microscope- Determination of: relative relief (RI) of minerals by Becke-line test, sign of elongation of minerals, pleochroic scheme of minerals, optic sign of uniaxial and biaxial minerals, extinction angle and its types. Identification of rock forming minerals in hand specimens. Chemical examination of Industrial and ore minerals / Blowpipe analysis.	12	CO4
V	Recognition of fossils, taxonomic classification, and assignation of age based on morphological characteristics of fossils belonging to Trilobita, Gastropoda, Bivalvia, Cephalopoda, Brachiopoda, and Echinodermata. Interpretation of paleoclimate and paleoenvironment based on fossil data. Biostratigraphic zonal assignment. Identification of source, reservoir and seal facies with fossil data.	12	CO5

	Text Books
1.	Battey, M.H., (1972). Mineralogy for students.
2.	Deer, W., Howie, R.A. & Zussman, J., (1996). The Rock forming minerals. Longman.
3	Hutchison, C.S., (1974). laboratory handbook of Petrographic Techniques. John Wiley.
4.	Murray, J.W., (1985). Atlas of Invertebrate Macrofossils, Longman.
5.	Woods, H., (1966). Invertebrate Paleontology, International Book Bureau.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Hans-Rudolt Wenk and Andrei Bulakh., (2004). Minerals - Their Constitution and Origin. Cambridge University Press.
2.	Berry Mason, (2004). Mineralogy, CBS Publishers, New Delhi.
3.	Putnis Andrew, (1992). Introduction to Mineral Science, Cambridge University Press.
4.	Benton, M.J. and Harper, D.A.T., (2009). Introduction to Paleobiology and the fossil record. Wiley-Blackwell. London.
5.	Jain, P.C., & Anantharaman, M. S., (1996). Paleontology, Evolution and Animal Distribution, Vishal Publications.

Web Resources	
1.	https://handbookofmineralogy.org/
2.	https://www.mindat.org/
3.	https://www.webmineral.com/
4.	https://www.paleosoc.org/
5.	http://paleoportal.org/

Course Outcomes

CO1: Students gain knowledge on the determination of attitude of beds
CO2: They can identify megascopic and microscopic study of minerals
CO3: Student can identify Megascopic and microscopic study of the minerals
CO4: To get knowledge about the theory and Origin of life
CO5: Students get more knowledge about vertebrate paleontology, Invertebrate paleontology

Mapping with Programme Outcomes

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

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

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

Programme Specific Outcomes

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

Semester-I

Elective-I: Geo-Statistics

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E01	Geo-Statistics	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	This course provides the learners to have an idea about the nature and variability of Earth Science Data sets
CO2	The course aims to introduce the different statistical operations done on such data enabling estimation, prediction, simulation and modeling
CO3	Knowledge of statistical procedures is inherent in data analysis and management
CO4	This course will help the students in the skill of data handling and data management
CO5	The students will be able to correlate between variables and use statistical procedures as estimators

UNIT	Details	No. of Hrs.	Course Objectives
I	Basic Statistics - Classification and presentation of statistical data, Characteristics of Normal distribution, measures of central tendency and dispersion, correlation, Least square method and regression analysis, probability and probability distributions, concept of population and sample, Sampling and sample distributions.	12	CO1
II	Central limit theorem; Concept and methodology of Hypotheses Testing and its application in geology - student's t test, F test, $\chi 2$ test, ANOVA (one way).	12	CO2
III	Concept of regionalized variable - semi variance & semivariogram, kriging, Basic spatial interpolation: nearest neighbors, inverse distance, trend surfaces, Introduction to simulation methods.	12	CO3
IV	Analysis of sequences of data: Markov chains, auto correlation and cross correlation, Univariate statistics: Measures tools of Location and Spread, Mean, median, variance, Standard Deviation. Univariate Plots: Histogram, Probability Density Function (PDF), Cumulative Density Function (CDF). Bivariate Statistics: Bivariate Data Display: Scatterplot or Cross plot, Bivariate Measures (Covariance, Correlation Coefficient).	12	CO4
V	Analysis of multivariate data, Map analysis. Fractals in Geology. Linear Regression, De-clustering.	12	CO5

	Text Books
1.	Cressie, N., (1993). Statistics for Spatial Data (Revised Ed.), John Wiley & Sons, Inc.
2.	Chiles, J. P. and Delfiner, P., (1999). Geostatistics: Modeling Spatial Uncertainty Wiley.
	References Books
1.	Peter J. Diggle, Paulo J. Ribeiro, Jr., (2007). Model-based geostatistics, Springer
2.	Schabenberger, O. and Gotway, C., (2005). Statistical Methods for Spatial Data Analysis Chapman & Hall/CRC.
	Web Resources
1.	*https://www.nrc.gov/docs/ML0227/ML022770097.pdf*
2.	*https://www.science.gov/topicpages/g/geostatistics*

Course Outcomes

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

Mapping with Programme Outcomes

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

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

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

Programme Specific Outcomes

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

Semester-I

Elective-II: Geo-heritage and Geo-tourism

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E02	**Geo-heritage and Geo-tourism**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	The concept of developing geoparks and geotourism will be introduced and a need for making laws to preserve them would be emphasized
CO2	An attempt will be made to familiarize the above fact in the mind of common man
CO3	The unique geological and geomorphologic features distributed throughout the country that constitutes its geoheritage
CO4	The development process obliterates many of these features and this loss necessitates
CO5	Due to the lack of awareness and stringent laws little efforts are being made to preserve these national treasures

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction and importance of geodiversity, geoheritage, geoconservation; geoparks and geotourism; History of the concept of geoheritage.	12	CO1
II	Geological outcrops and society; Threats to geodiversity; Conservation, protection, maintenance of geological sites and related features of National importance; Conservation of geosites as a tool to protect geoheritage.	12	CO2
III	Potential geoparks and geosites in India; Rajasthan, Odisha, Karnataka, Andhra Pradesh, Madhya Pradesh, Telangana, Tamil Nadu, Kerala, Gujarat, Himachal Pradesh	12	CO3
IV	UNESCO geoparks, geopark networks across the globe; geotourism and National geological Monuments.	12	CO4
V	Guidelines for selection of Geosites; Geoheritage laws, Role of local, state and national governments; Current status of geoheritage protection in the country; global geoheritage and protection laws.	12	CO5

	Text Books
1.	A Monograph on National geoheritage monuments of India, Indian National Trust for Art and Cultural Heritage, Natural Heritage Division, New Delhi.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Ranawat, P. S., George, S., (2016). Potential Geoheritage & Geotourism Sites in India International Journal of Scientific and Research Publications.
2.	Ezzoura Errami, Margaret Brocx Ed., (2009). Geoheritage, Geoparks and Geotourism Conservation and Management Series Springer.

Web Resources	
1.	https://www.springer.com/series/11639
2.	*https://www.gsi.gov.in/webcenter/portal/OCBIS/pages_pageGeoInfo/pageGEOTOURISM*

Course Outcomes

CO1: Student can understand about the geodiversity, geoheritage, geoconservation; geoparks and geotourism

CO2: To get knowledge about the maintenance of geological sites Tamilnadu

CO3: To get knowledge about the maintenance of geological sites and National geological Monuments

CO4: Students get more knowledge about global geoheritage and protection law

CO5: Student gain knowledge about the geological sites

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-I

Geological Mapping and Field Training

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1X01	**Geological Mapping and Field Training**	Extension Activity	Y	-	-	-	1	--	Highly Commended / Commended		

Course Objectives	
CO1	Acquiring practical knowledge through field visits and interaction with subject experts
CO2	Visits to important mines to observe and study various mining and exploration methods
CO3	Geological mapping and field training in igneous, sedimentary and metamorphic terrains
CO4	Understand the occurrence of various mineral resources across the country and world
CO5	Geological investigations, evaluation and interpretation of data

UNIT	Details	No. of Hrs.	Course Objectives
I	Use of clinometer and brunton compass for geographic directions, taking bearing and back bearing, strike and dip, reading of and locating oneself on toposheet – Use of GPS for co-ordinates and mapping of features – Geomorphological mapping (Two days).	12	CO1
II	Visit to igneous rock outcrops for mapping, collection of rock samples and field set-up studies – Mapping of dikes and veins – Thin section studies of rocks (Two days).	12	CO2
III	Visit to sedimentary terrain for mapping of strata and collection of fossils (Two days).	12	CO3
IV	Visit to metamorphic terrain for mapping of rocks and metamorphic structures, collection of rock samples – Thin section studies (Two days).	12	CO4
V	Geophysical investigations – Field measurements using gravity, magnetic and electrical methods (Two days).	12	CO5

Geological Mapping and Field Training: 7-10 days/60 hours

Students will be taken to the Geological Mapping and Field Training to the important geological sections, mines and industries in the country / states depending on the resources available. Besides, the students and faculty members shall visit national laboratories, institutions and the sites of natural hazards and geoheritage.

	Text Books
1.	Lisle, R.J., (1988). Geological Structures and Maps. Pergamon Press, Oxford.
2.	Brian Simpson., (1968). Geological Maps. Pergamon Press Limited, Oxford.

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

1.	Thomas, J.A.G., (1977). *An Introduction to Geological Maps*. George Allen and Unwin (Publishers) Limited, London. 2nd Edition.
2.	Bhattacharya, D.S. and Bagchi, T.C., (1973). *Elements of Geological Map Reading and Interpretation with Exercises*. Orient Longman Limited, Calcutta.

Web Resources

1.	Website related to Geology, Earth science, Geoscience , Geological science etc.,

Course Outcomes

CO1: Students learn the practical knowledge in the field visit
CO2: Students identify and collect the rock specimens in the field visit
CO3: Students experienced in mining areas and learn about the mining techniques.
CO4: Students get interaction with eminent scientist at various institutions during field visit
CO5: Students prepare the field training reports and gain knowledge about the geological sites.

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester- II

Stratigraphy of India and its Applications

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C05	**Stratigraphy of India and its Applications**	Core	Y	-	-	-	4	6	25	75	100

Course Objectives

CO1	Can recall the Stratigraphy of India
CO2	Can differentiate different deposits of geological time
CO3	To understand and compare different applications related to Stratigraphy
CO4	Can interpret the sequence of stratigraphic column
CO5	Can identify different processes involved during different geological time

UNIT	Details	No. of Hrs.	Course Objectives
I	Stratigraphy of India – Tectonic divisions, Cratons and Mobile belts of India. Dharwar Supergroup – Mineral riches of Archaean. Cuddapah System and its mineral riches. Vidhyan System and its mineral riches. Cambrian, Ordovician and Silurian Systems. Paleozoic Formations of India. Precambrian-Cambrian (pC/C) boundary.	12	CO1
II	Stratigraphy of India (Contd.) - Devonian and Carboniferous Systems. Gondwana Super group – Classification and Age, Stratigraphy and Structure, Life, Climate and Sedimentation– Economic importance of Gondwana Sequences. Carboniferous and Permian Systems –Triassic System – Lilang System –Permo-Triassic (P/T) Boundary-Jurassic System–Jurassic of Kutch–Cretaceous System – Cretaceous of Trichinopoly/ Tiruchirappalli, Mahadek Formation, Bagh beds. Cretaceous-Tertiary (K/T) Boundary.	12	CO2
III	Stratigraphy of India (Contd.) - Deccan Traps – Lameta Formation– Infra- and Inter-trappean beds – Age of Deccan Traps – Economic riches of Deccan Traps. Cenozoic History – Tectonics - Magmatic activity, Climate, Life, Rise of the Himalayas – Siwalik Group, Tertiary of Assam-Arakan region, Andaman-Nicobar Islands, Niniyur Formation, Cuddalore Formation, Quilon Formation. Neogene- Quaternary boundary. Quaternary tectonic activity, climate changes, sea level changes, fossil primates/ early man in India. Coastal sediments and its useful mineral deposits, Karewa Formation, Potwar Silts and Loess– Indo-Gangetic alluvium.	12	CO3
IV	Applications of Stratigraphy –Principles of Stratigraphy– Stratigraphic Classification and Correlation - Geological Time Scale - Geological time – Chronostratigraphic and time Units – Geochronology. Categories of Stratigraphic Classification – Incompleteness of the Rock record. Stratotypes and Type Localities - Golden spikes – Global Standard Section and Point (GSSP). Lithostratigraphy - Stratigraphic relationships - Lithostratigraphic Units – Lithodemic units – Application of Lithostratigraphy. Biostratigraphy – Nature of Biostratigraphic Units-Fossils and Stratigraphy — Biozones – Types of Biostratigraphic Units – Biostratigraphic correlation–Relationship of biostratigraphic Units to other stratigraphic units.	12	CO4

V	Applications of Stratigraphy (Contd.) - Dating and correlation techniques – Radiometric dating– Application of radiometric dating – Other isotopic and chemical techniques – Chemo stratigraphy. Magneto stratigraphy. Introduction to seismic and cyclo- and event stratigraphy. Sequence stratigraphy - Causes and controls of sequence development - Sea-level changes- Sea level changes and sedimentation–Depositional sequences and systems tracts–Parasequences– Sequence stratigraphy of carbonates– Sequence stratigraphy of siliciclastics - Applications of sequence stratigraphy.	12	CO5
	Text Books		
1.	M.S. Krishnan, (2010). Geology of India and Burma C.B.S publishers and Distributors, Delhi, 6th Edition.		
2.	D.N. Wadia, (1984). Geology of India, Tata McGraw Hill.		
3.	Ravindrakumar (1988). Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern ltd, New Delhi.		
4.	Ramakrishnan, M., & Vaidyanadhan, R., (2008). Geology of India. Vol. I, Geological Society of India, Bangalore.		
5.	Vaidyanadhan, R & M. Ramakrishnan, (2010). Geology of India. Vol. II, Geological Society of India, Bangalore.		
6.	Mehdiratta, R.C., (1974). Geology of India, Pakistan, Bangladesh and Burma. Atma Ram & Sons, New Delhi.		
7.	Pascoe, E.H., (1968). A Manual of the Geology of India & Burma (Vol. I - IV) Govt. of India Press, New Delhi.		
	References Books **(Latest editions, and the style as given below must be strictly adhered to)**		
1.	Doyle, P., & Bennett, M.R., (1996). Unlocking the Stratigraphic Record (John Willey).		
2.	Andrew D., Miall, (2016). Stratigraphy: A Modern Synthesis, Springer**.**		
3.	Dunbar and Roggers, (1964). Principle of Stratigraphy, John Wiley, New York.		
4.	Stamp L.D., (1964). An Introduction in Stratigraphy, Thomas Murby, Museum St, WCI, London.		
5.	Weller, J.M., (1962). Stratigraphic Principles and Practices, Harper & Bros, New York.		
6.	Ramkumar, M., (2015). Chemostratigraphy: Concepts, techniques and applications. Elsevier. The Netherlands.		
7.	Neil Craigie, (2018). Principles of Elemental Chemostratigraphy - A Practical User Guide. Springer.		
8.	Robert, M. S., (1989). Stratigraphy: Principles and Methods, Van Nostr and Reinhold, New York.		
9.	Murphy and Salvador, International Stratigraphic Guide — An abridged version, Episodes, (Edited, Vol. 22).		
10.	Hedberg, H.D., (1976). International Stratigraphic Guide, Jhon Wiley & Sons.		
11.	Code of Stratigraphic Nomenclature of India, (1977). Geological Survey of India. Miscellaneous Publication No. 20.		
	Web Resources		
1.	https://stratigraphy.org/		
2.	https://www.sepm.org/		
3.	https://www.geosocindia.org/		
4.	https://www.moes.gov.in/		
5.	https://isegindia.org/		

Course Outcomes

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester II

Igneous and Metamorphic Petrology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C06	**Igneous and Metamorphic Petrology**	Core	Y	-	-	-	4	6	25	75	100

Course Objectives

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

UNIT	Details	No. of Hrs.	Course Objectives
I	Generation of magmas. Genesis, properties, emplacement and crystallization of magmas. Steady-state geotherms. Magma mixing, mingling and immiscibility. Factors affecting their evolution and their relation to plate tectonics. Magmatic differentiation and Assimilation. Forms, textures and structures of igneous rocks. Origin of primary basic magmas. Classification of igneous rocks. Phase equilibrium studies of simple systems, Variation diagrams. Bowen's reaction series. Effect of volatiles on melt equilibria.	12	CO1
II	Silicate melts equilibria, binary and ternary phase diagrams. Experimental Petrology - Phase equilibrium of binary and ternary silicate systems and its petrological implications - Effect of Pressure on silicate systems - Trace elements in magmatic crystallization - Trace element modeling. Petrogenetic aspects of important rock suites of India: Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, alkaline rocks, dolerite, lamprophyre, kimberlites, ophiolites and granitoids.	12	CO2
III	Basic Concepts of Metamorphic Petrology - Types of metamorphism - agents of metamorphism - Zones and grades. Textures and structures of metamorphic rocks. Regional and contact metamorphism of pelitic and impure calcareous rocks. Mineral assemblages and P/T conditions. Experimental and thermodynamic appraisal of metamorphic reactions. Plate tectonics and metamorphic zones. Paired metamorphic belts.	12	CO3
IV	Analysis of polydeformed and polymetamorphosed rocks - Replacement textures and reaction rims. Classification of metamorphic rocks: Foliated and lineated rocks - Non-foliated and non-lineated rocks- Specific metamorphic types - High-strain rocks. Petrogenesis of important metamorphic rocks - granulites - eclogite - amphibolite - migmatites - khondalites.	12	CO4
V	Facies concept of metamorphism. Stable Mineral Assemblages in Metamorphic rocks: Equilibrium Mineral Assemblages - The Phase rule in Metamorphic systems - Chemographic diagrams: The ACF- AKF diagram - Projecting in chemographic diagrams. Metamorphic facies and facies series - Metamorphism of mafic rocks - Metamorphic fluids, Mass transport and Metasomatism – Anatexis, granitization and migmatization - Geothermobarometry.	12	CO5

	Text Books
1.	Philpotts, A., (1992). Igneous and Metamorphic Petrology, Prentice Hall.
2.	Turner, F.J., (1980). Metamorphic Petrology, McGraw Hill, New York.
3.	Best M.G., (2005). Igneous Petrology, Wiley, New Delhi.
4.	Hatch, F.H., et al., (2003). Petrology of the Igneous Rooks, CBS New Delhi.
5.	Hyndman, D.W., (1985). Petrology of the Igneousand Metamorphic Rocks McGraw Hill, New York.
6.	Ernst, W.G., (1976). Petrologic Phase Equilibria, W.H. Freeman & Co, USA.
7.	McBirney, A.R., (1993). Igneous Petrology. CBS Publishers and Distributors.
	References Books (Latest editions, and the style as given below must be strictly adhered to)
1.	Bose, M.K., (1997). Igneous Petrology, World Press.
2.	Bucher, K., and Frey, M., (1994). Petrogenesis of Metamorphic Rocks, Springer - Verlag.
3.	Winter, J.D., (2015). Principles of Igneous and Metamorphic Petrology, PHI. New Delhi.
4.	Middlemost E.A.K., (1985). Magmas and Magmatic Rocks. Longman UK.
5.	Winkler, H.G.F., (1970). Petrology of the Metamorphic Rocks. Springer, New Delhi.
	Web Resources
1.	https://minerva.union.edu/hollochk/c-petrology/resources.html
2.	https://topex.ucsd.edu/es10/lecture/lecture10/lecture10.html
3.	https://geology.com/rocks/igneous-rocks.shtml
4.	https://course.lumenlearning.com/wmopen-geology/chapter/outcome-metamorphic-rocks/
5.	https://serc.carleton.edu/NAGTWorkshops/coursedesign/goalsdb/10875.html

Course Outcomes:

CO1: To gain knowledge about the study of rocks - igneous, metamorphic, and sedimentary - and the processes that form and transform them

CO2: Students gain on Silicate melt equilibria, binary and ternary phase diagrams

CO3: students learn about the Basic Concepts of Metamorphic Petrology

CO4: Students learn Definition, measurements and interpretation of grain size

CO5: Students get knowledge on Sedimentary environments and facies

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester II

Sedimentary Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C07	**Sedimentary Geology**	Core	Y	-	-	-	4	6	25	75	100

Course Objectives	
CO1	Understanding the sedimentary system as major part of Earth's history
CO2	To analyze the causes and controls of formation of various Sedimentary rocks
CO3	To characterize and interpret individual facies types as the result of global-local scale processes
CO4	To understand the formation of sedimentary rocks, their depositional environments and Provenance for characterizing basin evolution
CO5	Understanding the links between sedimentary system and climate and environment

UNIT	Details	No. of Hrs.	Course Objectives
I	Definition and principles of sedimentology. Development of Sedimentology as an interdisciplinary subject of geoscience. Time and space in Sedimentology. Completeness of sedimentary record. Primary and indirect modes of data acquisition in Sedimentology. Definition, Controls and Classification of Sedimentary basins, Tectonics and Sedimentation – Paleocurrent, Provenance and Basin analysis. Sedimentary basins of India.	12	CO1
II	Rock cycle. Liberation and flux of sediments, Processes of sediment genesis, erosion, transport and deposition. Generation of sedimentary structures: Physical, chemical and biological sedimentary structures. Controlling factors of sedimentation — Tectonics, eustatic cycles, climate and sediment influx. facies concepts. facies association, facies succession, depositional models.	12	CO2
III	Sediment texture. Study of unconsolidated sediments- methods of particle size analysis-size distribution, mean, sorting, skewness and kurtosis. Classification of siliciclastics, carbonates, evaporites, volcanoclastics, and miscellaneous types. Porosity classification of sedimentary rocks, types, stages, and modifiers of porosity.	12	CO3
IV	Sedimentary environments and facies characteristics of Continental alluvial – fluvial, lacustrine, desert – Aeolian and Glacial sedimentary systems; Shallow Coastal Facies, Marine and Continental Evaporites; Shallow water Carbonates; Deep sea basins; Volcanoclasts. Petrography of rocks of Clastic, Chemical and Biochemical origin.	12	CO4
V	Diagenesis of sediments: Definition; Processes – physical and chemical compaction, micritization, boring, neomorphism, porosity modification, cementation; Stages, zones, and systems of diagenesis. Use of thin-section petrography, Scanning electron microscopy (SEM) and X-ray diffraction (XRD), and application of trace elements, Rare-earth elements and Stable isotope geochemistry to sedimentological problems.	12	CO5
	Text Books		
1.	Collins J.D., and Thompson, D.B., (1982). Sedimentary Structures, George Allen & Unwin, London.		

2.	Flugel, E.V., (2002). Micro facies analysis of lime stones. Elsevier.
3.	Leeder, M., (1999). Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592pp.
4.	Lindholm, R., (1988). A practical approach to Sedimentology. Blackwell publication.
5.	Nicholls, G., (1999). Sedimentology and Stratigraphy, Wiley-Blackwell,
6.	Pettijohn F.J., (1975). Sedimentary rocks, Harper and Row Publ., New Delhi.
7.	Selley, R.C., (2000). Applied sedimentology, Academic Press, 2nd Edition.
8.	Sengupta. S.M., (2007). Introduction to Sedimentology, CBS Publishers & Distributors, New Delhi.
9.	Tucker M.E., and Wright, V.P., (1990). Carbonate Sedimentology. Blackwell publication.
References Books	
1.	Samuel M., and Boggs Jr., (2006). Principles of Sedimentology and Stratigraphy.
2.	Gary Nichols, (2009). Sedimentology and Stratigraphy.
3.	Richard C., Selley, and Stephen A., Sonnenberg, (1985). Elements of Petroleum Geology.
Web Resources	
1.	https://cmgds.marine.usgs.gov/data/seds/index.html
2.	https://ocw.mit.edu/courses/12-110-sedimentary-geology-spring-2007/pages/lecture-notes/
3.	https://www.virtual-geology.info/sedimentology/
4.	https://serc.carleton.edu/NAGTWorkshops/sedimentary/search.html
5.	https://guides.library.utoronto.ca/c.php?g=251919&p=5069971

Course Outcomes:

CO1: To gain knowledge about the sedimentary system, methods and data collection protocols in sedimentology and introduction about controls of sedimentary basin evolution and overview on Indian sedimentary basins transform them.

CO2: To understand sediment genesis, study of sedimentary rock controls, sedimentary structures and facies concepts.

CO3: Characterize the sediments and rocks and evolutionary properties of porosity

CO4: Over view on sedimentary facies characteristics with reference to major genetic factors and regions

CO5: Understand the transformation of sediments into rocks and the methods of application of modern techniques in interpreting depositional and diagenetic environments and products.

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-II

Practical -II: Igneous & Metamorphic Petrology and Sedimentary Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1L02	Igneous & Metamorphic Petrology and Sedimentary Geology Practical	Core	Y	-	-	-	3	6	40	60	100

Course Objectives	
CO1	To compare and contrast different rock types by means of megascopic and microscopic studies
CO2	To enhance the knowledge about minerals in rocks using petrographic techniques
CO3	To carry out grain size analysis to distinguish genesis
CO4	To carry out grain size analysis to distinguish depositional environments
CO5	To carry out gravel analysis to establish of paleofluvial channels and provenance

UNIT	Details	No. of Hrs.	Course Objectives
I	Megascopic and microscopic study (textural and mineralogical) of the following igneous rocks: Granite, Syenite, Gabbro, Basalt, Peridotite, Pyroxenite, Dunite. Lamprophyres, Dolerite, Phonolite, Rhyolite, Trachyte, Andesite, Pitchstone, Anorthosite, Aplite, Pegmatite, Dolerite, Carbonatite, Diorite. Introduction to modal analyses of Granite, Basalt and Gabbro.	12	CO1
II	Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks: Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite-quartz schist, slate, talc-tremolite-calcite-quartz schist. Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble. Laboratory exercises in graphic plots for petrochemistry and interpretation of paragenetic diagrams.	12	CO2
III	Megascopic and microscopic study (textural and mineralogical) of the following Sedimentary rocks: Sandstone, Limestone, Conglomerate, Arkose, Mudstone. Identification and characterization of porosity types in sedimentary rocks at field, megascopic and microscopic scales.	12	CO3
IV	Harker's, Larsen's variation diagrams - Peacock's Alkali-Lime Index - Niggli's variation diagram.	12	CO4
V	Grain size analysis of unconsolidated sediments – Statistical parameters for sediment textural analysis – Frequency and cumulative frequency distribution curves–Moment and graphic measures– Facies analysis and paleoenvironmental interpretation.	12	CO5

	Text Books
1.	Vernon R. H., and Clarke G. L., (2008). Principles of metamorphic Petrology, Cambridge publication.
2.	John D. Winter, (2001). An Introduction to Igneous and Metamorphic Petrology.
3.	Wenk, H.R., & Bulakh, A., (2006). Minerals, Cambridge University Press, New Delhi.
4.	Perkins D., (2010). Mineralogy, Prentice Hall India, New Delhi. 3rd Edition.

5.	HaIdar, S.K., & Tisjlar, J., (2014). Introduction to Mineralogy and Petrology, Elsevier.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Yardley, B W D., (1990). An introduction to metamorphic petrology, ELBS publication.
2.	Best, M.G., (2002). Igneous and metamorphic petrology, Wiley publication.
3.	Deer, Howie and Hussmann, (1982). An Introduction to Rock forming Minerals, 2nd Edition, Orient Longman, London.
4.	Deer, W.A., R.A. Howie & J. Zussman, (1992). An Introduction to the Rock-Forming Minerals. ELBS. London.
5.	Berry L.G., Mason, & R.V. Dietrich, (1985). Mineralogy, CBS New Delhi.
Web Resources	
1.	https://en.m.wikipedia.org/wiki/mineral
2.	https://britannica.com/science/chlorite-mineral
3.	https://mineralseducationcoalition.org/minerals-database/zeolite
4.	https://www.britannica.com/science/epidote
5.	https://www.abracom.es

Course Outcomes:

CO1: Study the Megascopic and microscopic study for igneous rocks
CO2: Study the Megascopic and microscopic study for sedimentary rocks
CO3: Megascopic and microscopic study for metamorphic rocks
CO4**:** Statistical parameters in Sedimentology facies and porosity characterization
CO5: Preparation of Thin sections of the igneous rocks, metamorphic rocks and sedimentary rocks

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-II
Marine Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E03	**Marine Geology**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives

CO1	Understand the ocean morphology and formation
CO2	To know about the mineral resources of marine environment
CO3	Preparation man power to address ocean resources and environment
CO4	The course covers marine environments, depositional and erosional processes
CO5	Origin of oceanic basins and morphological features, and mineral resources

UNIT	Details	No. of Hrs.	Course Objectives
I	History of Marine Geology, Waves, tides, currents, turbidity currents, long shore currents, rip currents, circulation, Wave Action: wave reflection, refraction and diffraction - Seiche and tsunamis - Coastal Zone Morphology (Estuaries, deltas, bays, raised beaches, features of wave erosion and deposition, tombolos, mud banks) - Deep sea Morphology (Continental shelf, Continental slope, abyssal plains, sea mounts, guyots, fracture pattern.	12	CO1
II	Littoral processes - Evolution of headlands and bays - Beaches - Raised and sunken features - Evolution and classification of sea coasts and shore lines. Terrestrial-lacustrine-shallow marine-deep sea - siliciclastic versus carbonate sedimentation - deep ocean silica burps - shelf-to-basin transport phenomena turbidites and gravity flows - Submarine groundwater discharge.	12	CO2
III	Causes of marine regression and transgression - Description of important regressions and transgressions in the geological past - Eustasy -Origin and distribution of ocean basins - Paleoceanography- Ocean floor tectonics: Characteristics of Oceanic Plate - Geologic processes along Oceanic Plate boundaries - Seafloor Spreading - Evidence - lithospheric plates -divergent plate boundaries - Trenches as convergent plate boundaries - Subduction zones - Transform fault boundaries.	12	CO3
IV	Marine sedimentation - Sources, types and distribution of marine sediments - Transport of sea bottom sediment - Rate of deposition - Mineral resources. Marine phosphorite, glauconites, barium sulphate concretions, Polymetallic nodules - Gas hydrates - Beach placers. Terrigenous, Biogenic and Chemical Types - Placer Deposits. Distribution of temperature, salinity and density.	12	CO4
V	Trenches and Submarine Canyons - Bengal Fan. Biogenic structures: Reefs of corals and algae Mid-ocean ridges, and the structure of the oceanic crust - Coastal processes and the structure of continental margins. Coastal zone regulation in India - India as Pioneer Investor in Seabed mining. Seafloor volcanism and seismicity.	12	CO5
	Text Books		

1.	King, C.A.M., (1975). Introduction to marine Geology and Geomorphology. Edward Arnold, London.
2.	Radhakrishnan, V., (1996). General Geology V.V.P. Publishers, Tuticorin.
3.	Seabold, E. and Berger,W.H. , (1982). The Sea Floor, Springer Verlag. Kuenen, Ph.H., 1950. Marine Geology. John Wiley and Sons.
4.	Shepard, F.P., (1978). Geological Oceanography, Heinmann, London.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Harper and Row. Kurekian, K.K., (1990). Ocean, Prentice Hall. New Jersey.
2.	Svedrup, J.F., (1969). The Ocean, A Scientific American book, W.H. Freeman and company, San Francisco.
3.	Kennett,J.P. (1982). Marine Geology. Prentice Hall. New Jersey.
4.	Weisberg,C.P. (1979). Oceanography. McGraw Hill. New York.

Course Outcomes

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

CO2: Student gets knowledge on Pollution Monitoring studies

CO3: Students know about the Environmental Health hazard

CO4: Students learn the Waste management studies

CO5: Student get involved in Medical geology applications

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-II

Environmental Earth Science

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E04	**Environmental Earth Science**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	To identify knowledge on various types of environmental issues in relation to the Earth as a system
CO2	To explain the various causes of pollution
CO3	To explain the mechanisms of pollution
CO4	To select the remedial measures to be taken as an individual and a group
CO5	Understanding the medicals of the minerals in the Earth

UNIT	Details	No. of Hrs.	Course Objectives
I	Concept of environment - Environmental monitoring - Water as a resource, Water pollution - Point and non-point pollution sources - Ground water pollution.	12	CO1
II	Air pollution - Natural and anthropogenic sources of air pollution - Primary and secondary air pollutants - Anthropogenic activities and air pollution - Indoor air quality - Biological sources of indoor pollution - Health effects - Air quality standards - Case histories - Air quality monitoring - Acid rain - Adverse effects of acid rain - Health effects - Mitigation measures - Roles and responsibilities.	12	CO2
III	Smog - Mechanism of smog formation - Health disorders - Photochemical smog - Ozone and PAN formation - Health effects - Catalytic converters - Greenhouse gases and effect - Processes of removal of greenhouse gases.	12	CO3
IV	Methods of waste disposal - Landfills - Trash compactors - Incineration - Recycling - Biological processing - Mulch and compost - Energy production - Waste reduction - Waste handling and transport - Waste management - Concept of waste hierarchy - Education and awareness.	12	CO4
V	Medical Geology - Problems associated with fluoride, arsenic, asbestos, mercury, chromium, cadmium, zinc, copper and lead contamination - Alternate energy resources - Climate change.	12	CO5

	Text Books
1.	Fairbridge, R.W., (1972). Encyclopedia of Geochemistry and Environmental Science. John Wiley.
2.	Keller, Edward A., (1996). Environmental Geology. New Jersey: Prentice-Hall.
3.	Coppola D.P., (2007). Introduction to International Disaster Management, Butterworth Heinemann .
4.	Pine, J.C., (2009). Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group.
5.	Smith K, (2001). Environmental Hazards: Assessing Risk and Reducing Disaster Rout ledge, Press

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

Course Outcomes

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

CO2: Student gets knowledge on Pollution Monitoring studies

CO3: Students know about the Environmental Health hazard

CO4: Students learn the Waste management studies

CO5: Student get involved in Medical geology applications

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-II

Skill Enhancement Course: Gemmology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N02	**Gemmology**	SEC	Y	-	-	-	2	**	00	100	100

Course Objectives	
CO1	To learn and to examine the nature, quality, rarity of gemstones
CO2	To understand the physical and optical properties of gemstones
CO3	To summarize the origin, classification of gems
CO4	To give an idea about the gem testing instruments
CO5	To gain knowledge and to provide skills to become a successful gemologist

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction to Gems - Basic properties of gems. Formation of gem stones. Nature of gem material: quality necessary in gems-beauty, rarity, durability. Distinction between crystalline, amorphous and metamict materials. Crystal form and habit. Classification of gem stones. Observations with hand lens (10x)-importance and uses. Units of measurement: metric scale, carat, pearl and grain.	12	CO1
II	Nature of crystals: distinction between crystalline and amorphous material, crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones. Imitation stones.	12	CO2
III	Physical properties: hardness its applications in gemmology and limitations. Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Specific gravity-utility and determination by hydrostatic weighing, heavy liquids, floation and pycnometer. Inclusions and other features of gemstones. Generalities, Description, Properties and Identification of Biogenic Gem Materials.	12	CO3
IV	Optical properties: The electromagnetic spectrum, reflection and its importance in gemology-lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colors, labradorescence, inclusions etc. Laws of refraction, refractive index (R.I), total reflection- in design of refractometer. Construction and use of refractometer. Polariscope-construction and use in gemmology. Dichroscope-construction, use of Chelsea colour filter, Infra-red ultraviolet and x-rays in gem identification.	12	CO4
V	Enhancement and treatments- enhancement methods - coloured and colourless impregnation, dyeing, bleaching and its identification. Methods of treatment - laser drilling, irradiation, heat treatment, surface modifications, diffusion treatment and its identification. Composites - types, classification and identification.	12	CO5

	Text Books
1.	Karanth, K.V., (2000). Gem and gem industry in India, Memoir 45, Geological Society of India, Bangalore.
2.	Anderson, B.W., (1990). Gem testing, Butterworth Scientific, London, 10th Edition.
3.	Babu,T.M., (1998). Diamonds in India. Geological society of India, Bangalore.

4.	Hall, C., (1994). Gemstone, Dorling Kingsley, London.
5.	Deer, W. A., Howie, R. & Zussman, J., (1992). An introduction to rock forming minerals, ELBS, London.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Kerr, P.F., (1997). Optical mineralogy, 4th Ed. McGraw Hill Book & Co New York.
2.	Richard Laddicoat, (1987). Hand book of gem identification- G.I. A.
3.	Santa Monica., Edward Gubelin, (1986). Photo Atlas of Including in Gem Stones- ABC Edition Zurich, Gem Testing 10th Edition.
4.	Anderson, B.W., (1990). Butterworth Scientific London, Gemstone Enhancement 2nd Edition.
5.	Webster,R., (1995). Gem - Butter worths, London, Hall, C. Gem stones, 5th Edition.
6.	Peter Read, (1991). Gemmology- Butter worth-Heinemann Ltd., 2nd Ed

Course Outcomes

CO1: The course is focused on a comprehensive learning in gemology.
CO2: Understands the formation, classification to final grading and evaluation.
CO3: Apply Basic gemological techniques will be learned from this course
CO4: Knowledge and order to identify gemstones and simulants.
CO5: The students will acquire skills which will be useful to them in gem industry

Mapping with Programme Outcomes:

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

Second Year

Semester-III

Economic Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C08	**Economic Geology**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives

CO1	To study mineral deposits and processes of formation of deposits and the nature of different mineral deposits, its genesis and distribution of major ore minerals
CO2	To familiarize with the common ore minerals and their identifying criteria at various scales of study
CO3	To understand the genetic controls exerted by physical and chemical processes on ore formation in various geological settings
CO4	To provide the knowledge on geological processes responsible for mineral and ore formation, weathering and other secondary mineralization processes
CO5	To familiarize mode of occurrence of economic minerals, metallic and non-metallic minerals

UNIT	Details	No. of Hrs.	Course Objectives
I	Scope of economic geology. Mode of occurrence and morphology of ore bodies and relationship with host rocks -Textures and Structures of ore and gangue minerals. Modern concepts of ore genesis. Fluid inclusions -Wall rock alteration. Geothermometry- geobarometry.	12	CO1
II	Paragenesis and zoning in mineral deposits-Metallogenic Epochs and Provinces. Structural, physico-chemical and stratigraphic controls of ore localization. Study of ore forming processes- Orthomagmatic processes- Sedimentary processes- Metamorphic processes- Hydrothermal processes. Ore deposits in relation to plate tectonics.	12	CO2
III	Mineralogy, mode of occurrences, uses and distribution in India of the following metalliferous deposits - Iron, Manganese, Aluminium, Copper, Gold, Lead, Zinc - Chromium, Molybdenum, Rare Earth Group of metals. Distribution of mineral deposits in Indian shield; geological characteristics of important industrial mineral and ore deposits in India- Chromite, Diamond, Muscovite, Sn-W, Au, Fe-Mn, Bauxite; minerals used in Refractory, Fertilizer, Ceramic, Cement, Glass, Paint industries; minerals used as Abrasive, Filler; Building stones.	12	CO3
IV	The study of non- metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone, Garnet, Corundum, Calcite, Quartz, Feldspar, Clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Gem minerals.	12	CO4
V	Strategic, critical and essential minerals; India's status in mineral production; co-products and byproducts; consumption, substitution and conservation of minerals; National Mineral Policy; Mineral Concession Rules; marine mineral resources and its laws.	12	CO5

Text Books

1. Anthony Evans, (1993. Ore Geology and Industrial Mineral, John Wiley & sons, USA.

2.	Bateman Allan, M., (1962). Economic Mineral Deposits, Asian Publishing House, 2nd Edition.
3.	Coggin, B., and Dey, A.K., (1955). India's Mineral Wealth, Oxford University Press.
4.	Craig, J.M., & Vaughan, D.J., (1981). Ore Petrography and Mineralogy, John Wiley.
5.	Cuilbert, J.M., and Park, Jr. C.F., (1986). The Geology of Ore Deposits, Freidman.
6.	Gokhale, K.V.G.K., and Rao, T.C., (1978). Ore deposits of India, their distribution and processing, Thompson press.
7.	Meher, D.N. Wadia, (1994). Mineral of India, National Book Trust, New Delhi.
8.	Umeshwar Prasad, (2019). Economic Geology Economic Mineral Deposits.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Umathay, R.M., (2006). Mineral Deposits of India, Dattsons, New Delhi, India.
2.	Robb, L., (2005). Introduction to ore-forming processes, Blackwell publishing, U.K.
3.	Mookherjee, A., (2000). Ore Genesis-A Holistic Approach, Allied Publisher.
4.	James R. Craig and David J.Vaughan, (1994). Ore Microscopy and Petrography.
Web Resources	
1.	https://www.ualberta.ca/science/economic-geology
2.	https://pubs.geoscienceworld.org/economicgeology
3.	https://www.britannica.com/topic/economic-geology

Course Outcomes

CO1: This is the course which links directly to the industry and share the knowledge about a wide range of ore deposit the geometry of ore bodies, alteration patterns and assemblage of ore and gangue minerals

CO2: It offers a detailed study of origin of economic mineral deposits, its identification, properties, and distribution in India

CO3: The students will be familiar with how, where, and when earth's most important ore deposits have formed

CO4: This course also aims at providing a comprehensive knowledge in reflective light optic and ore textures

CO5: The students get a basic concept of mineral deposit modeling

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester III

Applied Micropaleontology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C09	**Applied Micropaleontology**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives	
CO1	To make the students well-versed in the field work, laboratory techniques and applications of Micropaleontology
CO2	To develop skills, innovation, research temperament and contribution to the geological sciences through critical thinking
CO3	Develop capability to identify the microfossils, determination of age of the sediments
CO4	Find solution to the geological problems through the application of microfossils
CO5	Work ethically in an interdisciplinary and multidisciplinary environment and correlation of scientific data

UNIT	Details	No. of Hrs.	Course Objectives
I	Definition, scope, historical developments of micropaleontology. Microfossils - definition, types of microfossils. Sampling methods, processing techniques used in separation of microfossils and preparation of faunal slides. Field and Laboratory equipments used for micropaleontological studies.	12	CO1
II	Foraminifera: habit, life cycle, dimorphism; test morphology, wall composition, wall structure, chamber shape and arrangements, aperture openings and ornamentation of foraminifera. Ecology, paleoecology, geological distribution and classification of foraminifera.	12	CO2
III	Ostracoda: Morphology, hinge types, ornamentation, ecology and paleoecology, geological distribution and classification. Nannofossils: Sample preparation techniques, morphology, ecology, paleoecology and geological distribution.	12	CO3
IV	Conodonts: Extraction methods, morphology, composition and stratigraphic utility of conodonts. Sample preparation techniques, major morphological groups and application of radiolarians and diatoms. Maceration techniques, outline of morphology and application of fossil spores and pollen.	12	CO4
V	Application of Microfossils: Significance of microfossils in biostratigraphy and correlation. Major mass extinction events in earth's history - types of global bio-events: causes and effects. Use of micropaleontology in hydrocarbon exploration. Importance of microfossils in interpretation paleoenvironment, paleotemperature and sea-level changes.	12	CO5

	Text Book
1.	Bignot, G., (1985). Elements of Micropaleontology. Graham and Trotman.
2.	Brasier, M.D., (1982). Principles of Microfossils. George Allen & Unwin.
3.	Glaessner, M.F., (1945). Principles of Micropaleontology. Hafner Publishing Company.
4.	Jones, D.J., (1969). Introduction to Microfossils. Hafner Publishing Company, New York.
5.	Loelich, A. R., (Jr.) & Tappan, J., (1988). Foraminifera Genera & Their Classification (V.1 & 2), VanNostrand Reynold.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Armstrong, H. and Brasier, M.D., (2005). Microfossils. Blackwell Publishing.
2.	Kathal, P. K., (2012). Applied Geological Micropaleontology, Scientific Publishers, New Delhi-Jodhpur.
3.	Saraswati, P. K. & Srinivasan, M. S., (2016). Micropaleontology, Principles & Applications, Springer.
4.	Martin, R.E., (2000). Environmental Micropaleontology, Springer.
5.	Haq, B.U. and Boersma, A., (1998). Introduction to Marine Micropaleontology, Elsevier.
Web Resources	
1.	https://en.wikipedia.org/wiki/Micropaleontology
2.	*https://www.britannica.com/science/micropaleontology*
3.	https://www.ucl.ac.uk/earth-sciences/research/micropalaeontology
4.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/micropaleontology
5.	https://egyankosh.ac.in/bitstream/123456789/69612/1/Unit-10.pdf

Course Outcomes

CO1: Student can understand about the fossil record and geological time-scale

CO2: To get knowledge about the theory and Origin and development and significance of Indian occurrence and distribution

CO3: Students get more knowledge about vertebrate paleontology

CO4: Students get more knowledge about Invertebrate paleontology

CO5: Student gain knowledge on micropaleontology: Sampling methods, sample processing techniques and application in petroleum exploration

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Hydrogeology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C10	**Hydrogeology**	Core	Y	-	-	-	4	4	25	75	100

Course Objectives

CO1	To define different terms and parameters involved in Hydrogeology
CO2	To enumerate the concept and to interpret the processes involved in groundwater
CO3	To describe the importance of groundwater and summaries the occurrence of groundwater
CO4	To interpret the conditions of water resources and to select some areas where the groundwater is being exploited against the natural laws
CO5	To critically assess different factors/aspects involved in exploration techniques

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction: Water on Earth - Types of water - Distribution of water - Hydrological cycle and its components: precipitation, evaporation, evapotranspiration, infiltration, surface runoff and sub-surface distribution and movement of ground water and their estimation for the purpose of assessing water availability. Water-bearing properties of rock formations: aquifer- isotropic and anisotropic, porosity, permeability, compressibility of rocks.	12	CO1
II	Occurrence and movement of Groundwater: Vertical distribution of groundwater: zone of aeration and zone of saturation - Geological formations as aquifers - Springs - Darcy's experiment and its limitations, fluid pressure, hydraulic conductivity, transmissitivity - Reynolds Number - Barometric and tidal efficiency of aquifers - Ground water flow- Groundwater flow direction -Unsaturated flow -Steady and unsteady state flow.	12	CO2
III	Water Wells: Types of wells - Well hydraulics - Cone of depression, radius of influence, drawdown and specific capacity - Drilling of shallow wells and deep wells - Well Completion - Well development - Testing wells for yield- Protection and rehabilitation of well- Collector wells and Infiltration galleries - Tracer tests and slug tests - Ground water budgeting - Ground water levels and water level maps - Safe yield and Conjunctive uses - Artificial recharge and methods.	12	CO3
IV	Groundwater Quality and Pollution: Chemical constituents in groundwater: sources and effects - Quality criteria for different uses - Geochemical cycle of surface water and ground water- Graphical presentation of groundwater quality data- Dissolved gases in groundwater- Impact of solar energy on groundwater - Sources and causes for pollution of groundwater – Pollution attenuation - Treatment for contaminated groundwater.	12	CO4
V	Exploration techniques and Saline water intrusion: Methods for exploration of ground water - Geological methods, Remote Sensing techniques, geomorphological inputs, gravity, magnetic, seismic and electrical methods - Basics of ground water modeling - Physical, analog and mathematical models, finite difference modeling - Hydrogeology of arid zones of India - Hydrogeology of wetlands. Hydrodynamic equilibrium of fresh and saline water - Ghyben-	12	CO5

	Herzberg relation- Control of saline water intrusion.		
	Text Books		
1.	Freeze, R.A. and Cherry, J.A., (1979). *Groundwater*. Prentice-Hall, London.		
2.	Fetter, C. W., (2018). *Applied Hydrogeology*. Waveland Press, 4th Edition. E-Book.		
3.	De Marsily, G., (1986). Quantitative Hydrogeology: Groundwater Hydrology for Engineers, Academic Press, Inc.		
4.	LaMoreaux, Philip E.; Tanner, Judy T, eds. (2001). Springs and bottled water of the world: Ancient history, source, occurrence, quality and use, Berlin, Heidelberg, New York:		
5.	Porges, Robert E. & Hammer, Matthew J., (2001). The Compendium of Hydrogeology, National Ground Water Association.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Todd, D.K. and Mays, L.W., (2013). *Groundwater Hydrology*. John Wiley & Sons, New York.		
2.	Davis and DeWeist, (1966). *Geohydrology*. John Wiley & Sons, New York.		
3.	Domenico, P.A., & Schwartz, W., (1998). Physical and Chemical Hydrogeology.		
4.	Driscoll, Fletcher, (1986). Groundwater and Wells, US Filter / Johnson Screens.		
5.	Anderson, Mary P.& Woessner, William W., (1992). Applied Groundwater Modeling, Academic Press.		
Web Resources			
1.	https://iah.org/		
2.	http://www.groundwateruk.org/		
3.	https://gw-project.org/books/groundwater-resource-development.		
4.	https://www.epa.gov/dwreginfo/drinking-water-regulations.		
5.	https://www.guidelinegeo.com/groundwater-prospection		

Course Outcomes

CO1: This study helps to understand the Hydrological cycle, Aquifer; flow rates and flow directions, Groundwater fluctuation: types, controlling factors

CO2: Occurrence and movement of Groundwater

CO3: Groundwater wells, types and methods

CO4: Groundwater chemistry: Components of ground water Groundwater pollution: Arsenic, fluoride and Nitrate

CO5: Salinity in Groundwater, Seawater intrusion and Ghyben-Herzberg Relation

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Applied Remote Sensing and GIS

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C11	**Applied Remote Sensing and GIS**	Core	Y	-	-	-	4	4	25	75	100

Course Objectives

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

UNIT	Details	No. of Hrs.	Course Objectives
I	Aerial photography: Introduction - Vertical and oblique photographs – Photo scale - Image displacement due to relief - Parallax in aerial photographs - Aerial photographic procedures - Camera and flight requirement - Flight planning - Filters - Compensation - Stereoscopy - Photomosaics. Photographical studies - Photo recognition elements and keys – Interpretation of lithology, structures and landforms from aerial photographs.	12	CO1
II	Fundamentals of remote sensing: History of remote sensing technology - Remote sensing system - Electromagnetic radiation - Spectral properties of terrestrial objects - Analysis of spectral reflectance curves - Types of satellites - Image acquisition - Multi-spectral scanners - Remote sensing resolution - Introduction to thermal remote sensing - Introduction to microwave remote sensing and new satellite sensors - Remote sensing in landform and land use mapping, structural mapping, coastal and ocean studies - Global and Indian space missions.	12	CO2
III	Image processing in remote sensing: Digital data recording - Digital data format. Introduction to digital image processing - Pre-processing techniques - Image classification methods - Image enhancement techniques.	12	CO3
IV	Applications of remote sensing: Visual interpretation - Different sensors - Data and image interpretation key elements. Exercises on mapping of geology - Land use/land cover and geomorphology based on visual method - Preparation of base maps and transformation of thematic maps. Validation of remote sensing analysis output by ground truth - Accuracy, estimation and introduction to GPS, DGPS, GNSS and Drone technology. Introduction to Hyperspectral remote sensing.	12	CO4

V	Fundamentals and application of GIS: Concept of GIS - GIS types - Data storage - Retrieval and analysis. GIS database organization and development - Combined use of remote sensing and GIS. Preparation of spatial decision support system (SDSS). Highlights on different applications using GIS tool with particular reference to Applied Geosciences and Ocean Science.	12	CO5
	Text Books		
1.	Asrar, G., (1989). *Theory and Applications of Optical Remote Sensing*. John Wiley & Sons, New York.		
2.	Curran, P.J., (1984). *Principles of Remote Sensing*. Longman Group Ltd.,		
3	Lillesand, T.M., Kiefer, R.W. and Chipman, J.W, (2007). *Remote Sensing and Image Interpretation.* Wiley India.		
4	Paul R. Wolf, (1986). *Elements of Photogrammetry*, McGraw-Hill Book company.		
5.	Lasaponara, R., and Masini N., (2012). Satellite Remote Sensing - A new tool for Archaeology. Remote Sensing and Digital Image Processing Series.		
	References Books		
1.	Sabins, F.F., (1998). *Remote Sensing Principles and Interpretation*. W.H. Freeman & Co.		
2.	Agarwal, C.S. and P.K. Garg, (2000). *Textbook on Remote Sensing In natural resources monitopring and management*, Wheeler Publishing.		
3.	Campbell, J. B., (2002). Introduction to remote sensing, The Guilford Press. 3rd Edition.		
4.	Jensen, J. R., (2007). Remote sensing of the environment: An Earth resource perspective Prentice Hall. 2nd Edition.		
5.	Richards, J. A.; X. Jia (2006). Remote sensing digital image analysis: an introduction Springer. 4th Edition.		
	Web Resources		
1.	https://stratigraphy.org/		
2.	https://www.sepm.org/		
3.	https://www.geosocindia.org/		
4.	https://www.moes.gov.in/		
5.	https://isegindia.org/		

Course Outcomes

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Practical III: Economic Geology, Micropaleontology and Hydrogeology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1L03	**Economic Geology, Micropaleontology and Hydrogeology**	Core	Y	-	-	-	3	6	40	60	100

Course Objectives	
CO1	To identify the economic minerals and its physical chemical properties
CO2	To describe the techniques of separation and identification of microfossils
CO3	To study of microfossil assemblages from various geological formations
CO4	To interpret groundwater flow direction from the topographic features
CO5	To critically assess the quality of groundwater

UNIT	Details	No. of Hrs.	Course Objectives
I	Economic Geology: Study of Industrial and ore minerals with special emphasis on physical, chemical characteristic mode of occurrences and uses. Native Ores, Oxides, Silicates, Carbonates, Phosphates, Halides, Fluorites, Sulphates and Sulphides.	12	CO1
II	Micropaleontology: Techniques of separation of microfossils from matrix. Types of microfossils: Calcareous, Siliceous, Phosphatic and organic walled microfossils. Study of morphological characters of important benthic, planktic, larger foraminifera and ostracoda and their use in ecology, paleoecology and biostratigraphy.	12	CO2
III	Preparation of oriented sections of larger benthic foraminifera, nannofossils, radiolaria and diatoms. Exercises on Biostratigraphy and interpretations. Study of microfossil assemblages from various geological formations and interpretation of environment, geological age. SEM applications in Micropaleontology.	12	CO3
IV	Aquifers and Aquitards: Factors affecting infiltration and ground water flow: Porosity - Permeability - Grain size - Specific yield - Specific retention - Hazen method for Hydraulic conductivity - Storativity. Groundwater flow: Specific discharge - Average linear velocity - Flow net - Flow across water table -Steady unidirectional flow - Unsteady radial flow.	12	CO4
V	Water chemistry: Solubility -Ionic strength of groundwater - Trilinear diagram - Oxidation potential *Eh.* Laboratory - Uses of Multiparameter - On field water parameter analysis techniques - Preparation of standards for analysis.	12	CO5

Text Books

1. Freeze, R.A., and Cherry, J.A., (1979). *Groundwater*. Prentice-Hall. London.
2. Fetter, C. W., (2018). *Applied Hydrogeology*.Waveland Press. 4th Edition.
3. De Marsily, G., (1986). Quantitative Hydrogeology: Groundwater Hydrology for Engineers, Academic Press, Inc.,
4. LaMoreaux, Philip E.; Tanner, Judy T, eds. (2001). Springs and bottled water of the world: Ancient history, source, occurrence, quality and use, Berlin, Heidelberg, New York.
5. Porges, Robert E. & Hammer, Matthew J., (2001). The Compendium of Hydrogeology, National Ground Water Association.

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

1.	Todd, D.K., and Mays, L.W., (2013). *Groundwater Hydrology*. *John* Wiley & Sons, New York, 3rd Edition.
2.	Davis and DeWeist, (1966). *Geohydrology*. John Wiley & Sons, New York.
3.	Domenico, P.A. & Schwartz, W., (1998). Physical and Chemical Hydrogeology, Wiley 2nd Edition.
4.	Driscoll, Fletcher, (1986). Groundwater and Wells, US Filter / Johnson Screens.
5.	Anderson, Mary P., & Woessner, William W., (1992). Applied Groundwater Modeling, Academic Press.
Web Resources	
1.	https://iah.org/
2.	https://gw-project.org/books/groundwater-resource-development/
3.	https://info.aquaclara.org/what-are-the-most-common-water-contaminants
4.	https://www.usgs.gov/mission-areas/water-resources

Course Outcome

CO1: The student will be able to identified ore and industrial minerals

CO2: Application of paleontology for paleoenvironment, climate, age determination, and hydrocarbon exploration.

CO3: Analytical ability to and knowledge on recognition, classification and interpretation of nanofossils, ichnofossils.

CO4: Student gets knowledge on Aquifers and Aquitards studies

CO5: Student learn about the Water chemistry

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Fuel Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E05	**Fuel Geology**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	The course offers a detailed study about natural fuels like coal and petroleum their formation and distribution especially in sedimentary basins
CO2	To make the students aware about unconventional energy resources like shale gas CBM and Gas hydrates, it also deals with the exploration and extraction techniques used in petroleum industry
CO3	Students shall benefit to have basic ideas about formations, nomenclature in constitution of coal, Development of comprehensive knowledge of utilization of coals
CO4	A working detail distribution of coals and coal industry in India, Sufficient idea of formation and entrapment of oil and gas
CO5	Elaborate understanding of oil exploration techniques and petroliferous basins of India

UNIT	Details	No. of Hrs.	Course Objectives
I	Coal Petrology: Origin of Coal; Classification and optical properties of macerals and microlithotypes. Techniques and methods of coal microscopy. Application of coal petrology. Classification of coal in terms of Rank, Grade and Type. Indian classification for coking and non-coking coals. International classifications (I.S.O. and Alpern's classification).	12	CO1
II	Coal as a source rock in petroleum generation. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India. Coal bed methane - a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coal bed methane exploration.	12	CO2
III	Petroleum - its composition and Properties; Origin (formation of Source rock Kerogen, organic maturation and thermal cracking of kerogen) and migration of petroleum. Reservoir rocks-porosity and permeability. Reservoir traps - structural, stratigraphic and combination traps. Oil field fluids - water, oil and gas.	12	CO3
IV	Methods of prospecting for oil and gas (geological modeling); Elementary knowledge of drilling and logging procedures - Oil shale - An outline of oil belts of the world. Onshore and offshore petroliferous basins of India. Oil policy of India. Gas Hydrates: Exposure to gas hydrates and future prospective.	12	CO4
V	Concept of atomic energy. Radioactive minerals. Mode of occurrence and association of atomic minerals in nature. Methods of exploration for atomic minerals. Productive geological horizons of atomic minerals in India, Geothermal energy: Principles of utilization of Earth's heat. Types of geothermal source-Applications, exploration, distribution of geothermal energy. Geothermal sources in India -Future scenario.	12	CO5
	Text Books		
1.	Chandra, D., Singh, R.M. Singh, M.P., (2000). Textbook of Coal (Indian context). Tara Book Agency, Varanasi.		

2.	Singh, M.P. (Ed.) (1998). Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
3	Scott, A.C., (1987). Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Publication no. 32, Blackwell scientific Publications.
4	Stach, E., et. al., (1982). Stach Textbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
5	Holson, G.D. and Tiratso, E.N., (1985). Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Tissot, B.P. and Welte, D.H., (1984). Petroleum Formation and Occurrence, Springer - Veralg.
2.	North, F.K., (1985). Petroleum Geology. Allen Unwin.
3.	Selley, R.C., (1998). Elements of Petroleum Geology. Academic Press.
4.	Durrance, E.M. (1986). Radioactivity in Geology-principles and application. Ellis Hoorwool.
5.	Dahlkamp, F.J., (1993). Uranium Ore Deposits. Springer Verlag.
6.	V Boyle, R.W., (1982). Geochemical prospecting for Thorium and Uranium deposits, Elsevier.

Course Outcomes

CO1: Students will have the knowledge and skills to recognise common ore minerals.

CO2: Demonstrate familiarity with a wide range of mineral deposits, including recognising the overall geometry, zonation and alteration patterns associated with specific classes

CO3: To get awareness on geochemistry of radioactive minerals

CO4: Fundamentals of coal petrology, Gain knowledge on the Origin, migration and entrapment of natural hydrocarbons

CO5: Student learns more knowledge on industrial aspects in geological studies.

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Isotope Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E06	**Isotope Geology**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	To provide knowledge on economically relevant radioactive minerals
CO2	To explain the abundances of unstable nuclides in earth
CO3	To provide practical knowledge on the minerals
CO4	Detail on the methods applied for mineral exploration
CO5	To summarize the radioactive mineral deposits

UNIT	Details	No. of Hrs.	Course Objectives
I	Discovery of radioactivity, stable and radiogenic isotopes. Literature on isotope geology. Nuclear structure, atomic weights, nuclear stability and abundance. Theory and mechanism of decay, particles emitted positron, negatron and alpha decay, effect of mineral/crystal structures, growth and retention of daughter isotopes in earth systems.	12	CO1
II	Abundances of unstable nuclides in earth, core, mantle, crust, oceans and different rock types; their decay schemes, radioactive elements as major elements, minor elements and trace elements and their geochemical behaviour. Mass spectrometer: Instrumentation, chemical separation, isotope dilution and ratio analysis.	12	CO2
III	Methods of dating: Isochron method, model/mineral ages, Fission track, ^{40}Ar-^{39}Ar, U and Th disequilibrium, choncordia method, ^{14}C, Be and Al. Interpretation and geological significance of ages.	12	CO3
IV	Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle.	12	CO4
V	Stable isotopes of oxygen and hydrogen, carbon, nitrogen and sulphur. Fractionation of stable isotopes in lithosphere, hydrosphere and atmosphere. Stable isotope geothermometry and geobarometry. Isotopes in mineral exploration, petroleum exploration, paleo-climate evaluation, health and environmental aspects.	12	CO5

	Text Books
1.	Doe, B.R., (1970). Lead isotopes. Springer Verlag.
2.	Faure, G. and Powell, J.L., (1972). Strontium Isotope Geology. Springer Verlag.
	References Books **(Latest editions, and the style as given below must be strictly adhered to)**
1.	Faure, G. (1986). Principles of Isotope Geology. John Wiley.
	Web Resources
1.	https://www.britannica.com/topic/economic-geology
2.	https://en.m.wikipedia.org/wiki/supergene-(geology)
3.	https://energymining.sa.gov.au/minerals/mineral-commodities
4.	https://www.slideshare.net/mobile/monokaonaBoruah/magmatic-deposits-economic-geology

Course Outcomes

CO1: Students will have the knowledge and skills to recognize common ore minerals.

CO2: Demonstrate familiarity with a wide range of mineral deposits, including recognizing the overall geometry, zonation and alteration patterns associated with specific classes

CO3: To get awareness on geochemistry of radioactive minerals

CO4: Fundamentals of coal petrology, Gain knowledge on the Origin, migration and entrapment of natural hydrocarbons

CO5: Student learns more knowledge on industrial aspects in geological studies.

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-III

Internship

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1I01	**Internship**	Core	Y	-	-	-	2	*	Highly Commended / Commended		

Course Objectives	
CO1	The students will enhance their writing skills
CO2	They will acquire knowledge about writing their assignments
CO3	They will delve into unchartered territory with regard to Scientific/Technical writing of research papers/reports
CO4	The students will understand what is Bibliography, how to cite references and how to quote them in the text
CO5	They will be trained in how to avoid redundancies, which constitute a major problem while writing a Scientific Paper/Technical Report

UNIT	Details	No. of Hrs.	Course Objectives
I	The Pre-Writing Stage: Why Write? -What is a Scientific Paper? - What is a Technical Report? Planning the Scientific Paper or Report: Structure-Headings-Note for Framework-Format-Keeping a Card Index-Assembling the Data. Contents of Scientific Papers; The Parts of a Scientific Paper-Preliminaries-Text-End Material.	12	CO1
II	Contents of Technical Reports: Types of Reports- Investigations-Proposals-Progress Reports-Information-Feasibility Study-Alternative Order. Illustrations and Tables: Maps-Line Drawings-Graphs-Photographs-Current Practices on Illustrations-tables.	12	CO2
III	Style and Form: Accuracy of Content-Clarity and simplicity of Expression-Coherence-Conciseness-Logical Sequence. AIDS To Writing: Grammar and Usage-Abbreviations-Compounding of words-Placement of Phrases- Italics-Numerical Expressions- Units and Symbols-Punctuation-Spelling-Conclusion.	12	CO3
IV	Writing Practices: Rewriting-Readability-Checklist- Preparation of Final Manuscript. on proof reading: Proof reading Requirements-Proof Reading Symbols- Modern Methods of MS Preparation. About Publishing: Procedures-Double Publishing-Authorship-Copyright-Cataloguing- Guarantees- Reproduction of Published Material-Royalty-Conference Proceeding.	12	CO4
V	Refrees, Formats and Proofs: Duties of a Referee- Standard Format Requirements-Editing of Proofs. Oral and Poster Presentations: Preamble-Mode of Oral Presentation-Aids to Oral Presentation-Poster Presentation. Project Proposals: Types of Project Proposals- The Strategy Project Proposals-Some formats of Project Proposals-Project Proposal Evaluation- Examples of Evaluations.	12	CO5
	Text Books		
1.	Whitesides, G., (2006). Writing a Scientific Paper Full text. Originally presented at the 231st National Meeting of the American Chemical Society (ACS) in Atlanta, GA of Chemical Information, CINF 17.		

2.	The Science of Scientific Writing Full text an article by George Gopen and Judith Swan, published in American Scientist, Vol. 78, No. 6 (November-December 1990).
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Cooray, P. G.**, (** 1992). Guide to Scientific and Technical Writing**.**
Web Resources	
1.	https://www.springer.com/journal/12594

Course Outcomes

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Exploration Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C12	**Exploration Geology**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives	
CO1	Explain the principles behind different geophysical surveying techniques
CO2	Process, analyze and interpret gravitational, magnetic and electromagnetic surveying data
CO3	To Understand the earth subsurface using electrical resistivity
CO4	To study the chemical properties of earth and application of chemistry in geology. To understand rock chemistry and evolution of various rock types through geochemical differentiation
CO5	To understand various surface guides for exploration of economical ores and minerals. To theories and the knowledge of Environmental Geochemistry

UNIT	Details	No. of Hrs.	Course Objectives
I	Geophysics: Introduction – Physical basis of geophysical exploration, various surface and sub-surface methods and their classification. Gravity prospecting – Principles, the Earth's gravitational field and units, its variation, Newton's Law. Order of anomalies produced by geological discontinuities, absolute and relative measurement of gravity, gravimeters and their operation in the field. Field procedure, reduction and correction of gravity field data, separation of regional and residuals, upward and downward continuation, interpretation of gravity data obtained over spherical and cylindrical objects, sheet, dike and faults – Applications of gravity methods.	12	CO1
II	Electrical methods – Electrical properties of earth materials – Conduction in rocks, conduction in water-bearing rocks, description of geoelectric sections, classification of electrical methods. Resistivity method – Ohm's Law, resistivity, factors affecting resistivity, effect of homogenous earth, various configurations for resistivity methods, configuration factor, response over a layered earth. AC and DC type resistivity meters, field procedure for electrical profiling and sounding, logarithmic curve matching, advantages of plotting the data on a logarithmic graph paper. Interpretation of profiling and sounding field data, use of modelling in electrical methods, introduction to self-potential, induced polarization methods.	12	CO2
III	Seismic methods – Fundamentals of elasticity – Young's modulus, Bulk modulus, Poisson's ratio, elastic waves, laws of reflection and refraction, Huygen's principle, Fermat's principle, Principle of superposition, Seismic wave theory – Helmhotz's theorem and seismic wave propagation – Body and surface waves – Primary, Secondary, Rayleigh and Love waves – Seismic energy sources – Detectors – Seismic noises and noise profile analysis – Reduction to a datum and weathering corrections - Short period, long period, broad band and strong motion – Seismic instruments – Seismic channel – Details of geophones – Filters, Amplifier and reproducible and non-reproducible recording – Seismic timer field layout – Arc shooting – Fan shooting – Profile shooting.	12	CO3

IV	Principles of Geochemistry: Introduction - Periodic table, Geochemistry of the Earth; Formation of the solar system and geochemical history of the earth. The geochemical cycle- Distribution of elements in rocks and soils. Geochemistry of Minerals, Rocks and Waters: Mineral stability, compositional changes in minerals. River water, Seawater, Seafloor hydrothermal systems; Groundwater and Lakes. Characteristics of Magma, melting of rocks, Water in Magmas, eutectic and melting. Distribution of trace components between rocks and melts.	12	CO4
V	Exploration Geochemistry: Introduction - Primary dispersion pattern, Secondary dispersion pattern - background values. Geochemical anomaly - geochemical sampling. Principles and techniques used in the design and implementation of an exploration geochemical survey. Environmental Geochemistry: Anthrosphere aquatic environment - Marine, fluvial, lacustral, aerosols. Perturbations caused by human activity.	12	CO5
	Text Books		
1.	Arthur Brownlow, (1996). Geochemistry Pearson Education, INC., Australia, 2nd Edition.		
2.	Faure, G, (1998). Principles and applications of Geoche4msitry, Pearson Education, INC, Australia		
3.	Criss, R.E., (1999). Principles of stable Isotope distributions. Oxford University Press, U.K.		
4.	Lajtha, J. and Michener, R., (1994). Stables isotopes in ecology and environmental Science, Blackwell, U.K.		
5.	Mason, B. and Moore, and C.B., (1982). Principles of Geochemistry.		
6.	Keller, G.V., and Frischknecht, F.C., (1982). Electrical Methods in Geophysical Prospecting. Pergamon Press, New York.		
7.	Rama Rao, B.S. and Murthy, I.V.R., (1978). Gravity and Magnetic Methods of Prospecting. Arnold Heinemann Publishers, New Delhi.		
8.	Davies, Geoffrey F., (2001). Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press.		
References Books			
(Latest editions, and the style as given below must be strictly adhered to)			
1.	John V. Walther, (2005). Essentials of Geochemistry, Jones and Bartlett Publishers, Boston.		
2.	Girard, (2005). Principles of Environmental Chemistry, Jones and Bartlett Publishers, Boston.		
3.	Nelson EBY, G., (2004). Principles of Environmental Geochemistry, Thomson Brooks/Cole, UK.		
4.	Dobrin, M.B., (1984). An Introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.		
5.	Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D.A. (1976). Applied Geophysics. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi.		
Web Resources			
1.	https://earthref.org/GERM/#gsc.tab=0		
2.	https://georoc.eu/georoc/new-start.asp		
3.	https://www.geochemsoc.org/		
4.	https://www.usgs.gov/centers/gggsc/science/geochemistry		
5.	https://www.internetchemistry.com/chemistry/geochemistry.php		

Course Outcomes

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

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

CO3: Thermal and electrical properties of rocks, resistivity method

CO4: Application of electrical method in groundwater exploration

CO5: The student is introduced to a detailed discussion, study, and principles of geochemistry; students can understand the sophisticated instrumental operations for analysis

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Mining and Engineering Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1C13	**Mining and Engineering Geology**	Core	Y	-	-	-	4	5	25	75	100

Course Objectives

CO1	To employ the students in geotechnical investigations and make them understand the various mining methods adopted in addition to estimation of ore reserves
CO2	To understand the underground mining methods in geology
CO3	To understand the Coal mining methods in geology
CO4	To calculate and problems pertain to tunneling in hard and soft grounds
CO5	To briefly summarise the properties and significance of different Earth materials on the basis of engineering geology

UNIT	Details	No. of Hrs.	Course Objectives
I	Mining Geology: Terminology used in metal mines - Terminology used in coal mines - Prospecting and exploration - Alluvial mining methods - Quarrying - Opencast mining - Mine supports - Mine Atmosphere. Mathematical Problems Pertaining to Mining and Engineering Geology.	12	CO1
II	Methods of underground metal mining: Without artificial supports - With artificial supports - Cut and fill methods - Shrinkage stoping - Caving methods.	12	CO2
III	Coal Mining: Longwall advancing - Longwall retreating – Board and Pillar method - Horizon mining.	12	CO3
IV	Problems pertain to tunneling in hard and soft grounds - Geological investigations preceding tunneling - Geological investigations pertaining to harbors, docks, coastal erosion - Shoreline engineering - Construction of retaining walls - Problems and solutions.	12	CO4
V	Engineering Geology: Engineering properties of rocks, soft sediments and soils - Geological investigations pertaining to bridges, buildings, dams, highways and airfields - Types of reservoirs - Geological investigations of reservoir sites.	12	CO5

Text Books

1. Arogyaswamy, R.N.P., (1996). *Courses in Mining Geology*. 4th Edition. Oxford and & IBH Publishing Co., New Delhi.
2. Peters, W.C., (1978). *Exploration and Mining Geology*. 2nd Edition. John Wiley & Sons, New York.
3. Vitousek P.M, Global Change and Natural Resource Management, Beyond global warming: Ecology and global change. Ecology 75.
4. Miller T.G. Jr, Environmental Science, Wadsworth Publishing Co.
5. Thomas, R.T., (1986). Introduction to Mining methods, McGraw Hill, New York.
6. Mckinstry, H.E., (1980). Mining Geology, Prentice Hall, N.Y., Parbinsingh 1991.
7. Peters, W.C., (1987). A Text Book of Engineering & General Geology. Kataria & Sons.
8. Parbin Singh, (2013). Engineering & General Geology, S.K. Kataria & Sons.

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

1.	Blyth, F.G.H., (1963). *A Geology for Engineers*. 4th Edition. The ELBS & Edward Arnold (Publishers) Ltd., London.
2.	Legget, H.F. and Hathaway, A.W., (1988). *Geology and Engineering*. McGraw-Hill Book Co., New York, 3rd Edition.
3.	Gupta, H.K. and Rastogi, B.K., (1976). Elements of mining Technology Dhanbad publishers., Dhanbad.
4.	Singh, R.D., (1998). Coal Mining, New Age Publishers, New Delhi.
5.	Hartzman, H.L., (1992). SME Mining Engineering Handbook, SME Colorado, USA.
6.	Schultz, J.R. & Cleaves, A.B., (1951). Geology in Engineering, John Wiley & Sons.
Web Resources	
1.	https://link.springer.com/chapter/10.1007/
2.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/
3.	https://www.google.com/ur1?sa=t&source=web&rct=j&ur1=https//mines.gov.in/
4.	https://www.ncbi.nml.gov/books/
5.	https://www.sciencedirect.com/sciencedirect.com/science/article/pii/

Course Outcomes

CO1: Students can understand the Engineering properties of rocks
CO2: Students can apply the knowledge and ideals on geological investigations for constructions
CO3: Getting knowledge about the alluvial mining methods
CO4: Study the methods of underground metal mining
CO5: Understand the knowledge about the coal mining methods and techniques

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Practical IV: Remote Sensing & GIS, Exploration Geology and Mining Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1L04	**Remote Sensing & GIS, Exploration Geology and Mining Geology**	Core	Y	-	-	-	3	6	40	60	100

Course Objectives	
CO1	To understanding of the basics, the students are expected to do thorough interpretation of aerial photographs
CO2	To briefly summarise the comprehend of remote sensing i.e. spectral properties of earth objects
CO3	To briefly summarise the various exploration methods Earth observation
CO4	To briefly summarise the various mining methods adopted in addition to estimation of ore reserves
CO5	To critically assess the drilling processes of the rocks, minerals and ores

UNIT	Details	No. of Hrs.	Course Objectives
I	Aerial Photography: stereovision test, pocket & mirror stereoscope – 3D observation, demarcation of marginal information, identification photo recognition elements. Interpretation of drainage pattern, landforms, rock types and structures.	12	CO1
II	Satellite Remote Sensing: decoding of satellite data, interpretation of satellite data for geomorphology, structure and lithology. Exposure to digital image processing techniques, spectral plot for different features. GIS: scanning, digitization, preparation of vector and raster image, geo-referencing. Overlay analysis. Network analysis, proximity analysis. Digital elevation model.	12	CO2
III	Exploration Geology: analysis of rocks/minerals/ores - analysis of water - elemental analysis - flame photometry - spectrophotometry - analysis of trace elements using AAS - ICPMS - radioactive dating methods.	12	CO3
IV	Mining Geology: assaying - determination of average grade - determination of average width - uniform sampling - variable sampling - influence of interval.	12	CO4
V	Drilling: core and sludge recovery - estimation of ore reserves - determination of coal pillar size - determination of ideal shaft location.	12	CO5

	Text Books
1.	Krynine, D.P. and Judd, W.R., (1957). *Principles of Engineering and Geotechniques.* McGraw-Hill Book Co., New York.
2.	Legget, H.F., (1962). *Geology and Engineering*. McGraw-Hill Book Co., New York.
3.	Dobrin. M.B., (1981). Introduction to Geophysical prospecting. McGraw-Hill.
4.	Mason. B., (1966). Principles of geochemistry- Willey Toppan.
5.	H.E. Hawkes and Webb, (1965). Geochemistry in Mineral Exploration, Harper and Row Publishers.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Zaruba, Q. and Menci, V., (1976). *Engineering Geology*. Elsevier Scientific Publishing Co., Amsterdam
2.	Arogyaswamy, R.N.P., (1980). *Courses in Mining Geology*. 2nd Edition. Oxford and & IBH Publishing Co., New Delhi.
3.	Govett, G.J.S., (1983). Handbook of Exploration Geochemistry.
4.	Craig, R.C & Vaughan, D.V., (1985). Ore Microscopy and Ore Petrography. Wiley. New York.
5.	Aiyengar, N. K. N., (1964). Minerals of Madras, Dept. of Industries & Commerce. Guindy, Madras.
Web Resources	
1.	1. https://www.Sciencedirect.com
2.	https://www.geos.iitb.ac.in
3.	https://pubs.usgs.gov
4.	https://www.britannica
5.	https://www.intechopen.com

Course Outcomes

CO1: The student is introduced to a detailed discussion, study, and application of engineering properties of rocks

CO2: Student can learn the formulas for Estimation of ore reserves

CO3: Student learn the mining geology calculations

CO4: Students can understand the sophisticated instrumental operations for analysis

CO5: Student apply the techniques for analysis of rocks/minerals/ores.

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Oceanography and Climatology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E07	**Oceanography and Climatology**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	To learn the physical and chemical components and phenomena related to oceanography and climatology
CO2	To understand the morphologic and tectonic domains of the ocean floor
CO3	Compare and Contrast cloud physics and Physical Meteorology
CO4	Critically assess the ocean current patterns and cloud-climate classifications
CO5	To differentiate and understand the different Oceanic Currents

UNIT	Details	No. of Hrs.	Course Objectives
I	Oceans and Atmosphere Hypsography of the continents and ocean floor -continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans. Biological productivity in the oceans.	12	CO1
II	Structure and chemical composition of the atmosphere, lapse rate and stability, scale height, geopotential, greenhouse gases and global warming. Cloud formation and precipitation processes, heat budget, radiation balance. El Nino Southern Oscillation (ENSO). General weather systems of India, - Monsoon system, cyclone and jet stream, Western disturbances and severe local convective systems, distribution of precipitation over India. Marine and atmospheric pollution, ozone depletion.	12	CO2
III	Morphologic and tectonic domains of the ocean floor. Structure, composition and mechanism of the formation of oceanic crust. Hydrothermal vents-. Ocean margins and their significance. Ocean Circulation, Coriolis Effect and Ekman spiral, convergence, divergence and upwelling, El Nino - La Nina, Indian Ocean Dipole Thermohaline circulation and oceanic conveyor belt.	12	CO3
IV	Physical Meteorology: Thermal structure of the atmosphere and its composition. Radiation: basic Laws - Rayleigh and Mie scattering, multiple scattering, radiation from the sun, solar constant, effect of clouds, surface and planetary albedo. Emission and absorption of terrestrial radiation, radiation windows, radiative transfer, Greenhouse effect, net radiation budget; Clausius - Clapeyron equation.	12	CO4
V	Cloud Physics: Cloud classification, condensation nuclei, growth of cloud drops and ice-crystals, precipitation mechanisms: Bergeron, Findeisen process, coalescence process. Atmospheric turbulence: Mixing length theory, planetary boundary layer equations, surface layer, Ekman layer, eddy transport of heat. Richardson criterion.	12	CO5
	Text Books		

1.	Kennett, J.P., (1982). *Marine Geology*. Prentice Hall, London.
2.	Seibold, E. and Berger, W.H., (1982). *The Sea Floor*. Springer Verlag, Berlin
3.	Sverdrup, Harald Ulrik, et al., (1942). The Oceans, Their Physics, Chemistry, and General Biology. New York: Prentice-Hall.
4.	Rice, A. L. (1999). "The Challenger Expedition". Understanding the Oceans: Marine Science in the Wake of HMS Challenger. Routledge.
5.	Benjamin Franklin's 'Sundry Maritime Observations'". Archived from the original on 18 December 2005.
References Books	
1.	Strahler, A.N. and Strahler, A.H., (1987). *Modern Physical Geography*. 3rd Edition. John Wiley & Sons, New York.
2.	Strahler, A.N., (1974). *Physical Geography*. 4thEdition.John Wiley & Sons, New York.
3.	Boling Guo, Daiwen Huang, (2004). Infinite-Dimensional Dynamical Systems in Atmospheric and Oceanic Science, World Scientific Publishing.
4.	Hamblin, Jacob Darwin, (2005). Oceanographers and the Cold War: Disciples of Marine Science. University of Washington Press.
5.	Lang, Michael A., Ian G. Macintyre, and Klaus Rützler, eds. Proceedings of the Smithsonian Marine Science Symposium. Smithsonian Contributions to the Marine Sciences, No. 38.
Web Resources	
1.	https://en.wikipedia.org/wiki/British_Oceanographic_Data_Centre
2.	https://psl.noaa.gov/data/gridded/tables/ocean.html
3.	http://www.vega.org.uk/video/
4.	https://unesdoc.unesco.org/ark:/48223/pf0000030893
5.	http://www.mcirano.ufba.br/ftp/books/baum_04.pdf

Course Outcomes

CO1: Students can introduce into the Physical and chemical properties of sea water
CO2: Students learn about the Structure and chemical composition of the atmosphere
CO3: Gain knowledge in the Morphologic and tectonic domains of the ocean floor Structure
CO4: Students can introduce into Physical Meteorology
CO5: Studied and gain knowledge on Cloud Physics

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV
Petroleum Exploration

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1E08	**Petroleum Exploration**	Elective	Y	-	-	-	3	4	25	75	100

Course Objectives	
CO1	To understand the origin, migration and accumulation of hydrocarbons
CO2	To provide a comprehensive understanding of reservoir rocks, traps, distribution of petroleum and petroliferous basins in India
CO3	To learn the physical and chemical properties of petroleum, isotopic analysis and modelling of petroleum systems
CO4	To obtain the knowledge on the modern methods of drilling and their applications
CO5	To develop analytical skills for modelling, prediction, assessment and interpretations of data

UNIT	Details	No. of Hrs.	Course Objectives
I	Fundamentals of Petroleum Geology: Origin, migration and accumulation of oil and gas. Classification of petroleum– solid, liquid and gaseous forms. Source rocks, transformation of organic matter to petroleum- biochemical changes, geochemical changes – temperature, pressure, radioactivity, catalysts. Migration of petroleum- Primary migration - compaction, capillary action, bacterial action. Secondary migration – differential specific gravity, hydraulic movement of currents, differential gas pressure, cementation and diastrophic movements. Distance of migration. Accumulation of oil – Pools, fields and provinces.	12	CO1
II	Reservoir rocks - Classification of reservoir rocks – Fragmental reservoir rocks, chemical, biochemical reservoir rocks and miscellaneous reservoir rocks. Cap or roof rocks. Oil Traps – Structural traps, stratigraphic traps and combination traps. Salt domes. Petroleum accumulation as related to marine transgression and regression. Geographic distribution of petroleum, stratigraphic distribution of petroleum. Geology of the important petroliferous basins in India – Cambay, Bombay, Krishna-Godavari, Cauvery and Assam.	12	CO2
III	Physical and Chemical properties of Petroleum – colour, odour, specific gravity, viscosity, flash point, optical activity, boiling point, fluorescence; chemistry of petroleum - Paraffins, olefin series, acetylene series, diolefin series, benzene series and naphthalene series. Other petroleum constituents – sulphur compounds, nitrogen compounds, oxygen compounds and inorganic constituents. Isotopic analysis of source rock and its correlation. Recent advances in petroleum analysis. Modelling of petroleum systems, isotopic analysis of shale gas and biomarker analysis.	12	CO3
IV	Introduction to drilling methods: types of drilling operations, designing of oil well. Down hole equipment: drilling rigs, its components and functions. Drilling fluids, well-heads, casing and cementing operations. Principles of kick control, fishing jobs. Drilling methods and equipment for directional, horizontal and multilateral wells. Types of offshore	12	CO4

	drilling rigs. Modern methods of drilling, stability analysis, automation and monitoring.		
V	Duties of a well-site geologist. Geotechnical order. Mud logging. Formation evaluation (LWD) Measurement-while-drilling (MWD). Modelling, Prediction, Assessment and Data interpretations. Archie's Formula- porosity, permeability, Preparation of composite logs. Well completion, Enhanced oil recovery -gas hydrates and coal bed methane.	12	CO5
	Text Books		
1.	Levorsen, A.J., (2004). *Geology of Petroleum*, CBS Publishers and Distributors Pvt. Ltd., Chennai. 2nd Edition.		
2.	Bhagwan Sahay, (1997). *Petroleum Exploration and Exploitation Practices*, Allied Publishers Limited, Chennai. 2nd Edition.		
3.	Geology & Mineral Resources of the States of India, (2005). Misc. Pub.No.30. Geological Survey of India. Kolkota. (Several individual volumes available online at GSI portal).		
4.	Brian Frehner, (2011). Finding Oil: The Nature of Petroleum Geology, 1859-1920 (University of Nebraska Press.		
5.	Hobson, J.D. and Tirastoo, E.N., (1975). Introduction to Petroleum Geology, Scientific Pub; Becons Field.		
	Shelly R., (2000). Elements of Petroleum Geology. II ed, Academic Press, London.		
	References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Hunt, J.M., Petroleum Geochemistry and Geology, (1996). W. H. Freeman, San Francisco, 2nd Edition.		
2.	Richard, C. Selley, (1998). Elements of Petroleum Geology, Academic Press, London.		
3.	Hobson G.D., Developments in Petroleum Geology, Vol. I, 1997, Vol. II 1980, Applied Science Publishers, London.		
4.	Guillemot, J., (1991). Elements of Geology – Oil and gas exploration techniques. Technip Pub., Paris.		
5.	Chapman, R.E., (1983). Petroleum Geology, Developments in Petroleum Science, Ser. 16, Elsevier, Amsterdam.		
	Web Resources		
1.	Society of Petroleum Engineers (SPE): www.spe.org		
2.	American Association of Petroleum Geologists (AAPG): www.aapg.org		
3.	Petroleum Geology e-Library: www.petroleumgeology.org		
4.	Society of Petroleum Engineers (SPE): www.spe.org		
5.	American Association of Petroleum Geologists (AAPG): www.aapg.org		
6.	Geo Science World : https://www.geoscienceworld.org		
7.	US Energy Information Administration (EIA): https://www.eia.gov		
8.	PetroWiki by SPE : https://petrowiki.spe.org		
9.	OnePetro : https://onepetro.org		
10.	National Oceanic and Atmospheric Administration (NOAA):https://www.noaa.gov		

Course Outcomes

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Skill Enhancement Course: Disaster Management

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N03	**Disaster Management**	SEC	Y	-	-	-	3	**	00	100	100

Course Objectives	
CO1	Understand the basics of natural hazards, distinguish hazards and disasters, global trends, vulnerable communities, importance of inter-disciplinary studies
CO2	Students will comprehend the core part of disaster management i.e. geotechnical aspect, community aspect and environmental aspect and its inter-linkages
CO3	Comprehend the complexity of climate change induced disasters, mapping and monitoring techniques including risk zonation and appropriate technology tools for mitigation
CO4	Acquiring knowledge on community-based disaster management, disaster risk reduction (DRR), community resilience and the importance of hazard mapping
CO5	Evaluate the importance of this inter-disciplinary course through case study experiences and to use these skills in the real-world scenario

UNIT	Details	No. of Hrs.	Course Objectives
I	General introduction to natural hazards and disasters: Physical and geodynamic characteristics of earthquakes, tsunamis and storm surges, tropical cyclones, monsoonal floods, landslides. Droughts - different types - monitoring and management and wildfires - Worldwide trends in natural catastrophes and occurrence.	12	CO1
II	Global Climate Change: Global warming and environmental change - Threat of sea level changes on global coasts - Impact on natural resources, environment - Social impact of disasters Gender, food security, poverty and Climate Change Adaptation.	12	CO2
III	Assessment: Hazard-prone areas identification - Application of remote sensing and GIS tools - Hazard mapping - Risk modeling - Risk zonation and case studies.	12	CO3
IV	Preparedness: Risk reduction concepts - Pre- and post-disaster comparison and analysis - Understanding the disaster cycle - Stakeholders' participation and preparation of comprehensive management plans - Community-based disaster risk management - Participatory risk assessment - Coastal regulations - Coastal management in tsunami reconstruction - National and international scenarios.	12	CO4
V	Mitigation and recovery: Inter-relationship between mitigation and recovery - Process for developing hazards mitigation plan, implementation of comprehensive mitigation strategies - Disaster recovery planning - Disaster emergency preparedness and on recovery and reconstruction - Disaster Risk Reduction (DRR) approaches - Early warning systems.	12	CO5

	Text Books
1.	H. Rodriguez et al., (2006). Handbook of Disaster Research Eds.
2.	Rajib Shaw and Krishnamurthy, R.R., (2008). Disaster Management - The Global
	Challenges and Local Solutions, Universities Press, Hyderabad.

3.	Karanth, K.R., (1987). Groundwater Assessment Development and Management, Tata McGraw Hill Publishing Company, Ltd.
4.	Miller T.G., (2004). Environmental Science. Wadsworth Publishing.
5.	Coates, D.R., (1984). Environmental Geology. McGraw Hill, New York.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Shaw, R. and Rouhban, B., (2005). Disaster Reduction and Human Security. UNESCO & Kyoto University.
2.	Babar, Md., (2007). Environmental Changes and Natural Disasters. New Delhi Publishing Agency.
3.	Coppola D.P., (2007). Introduction to International Disaster Management, Butterworth Heinemann.
4.	Pine, J.C., (2009). Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group.
5.	Smith, K., (2001). Environmental Hazards: Assessing Risk and Reducing Disaster Rout Ledge Press
Web Resources	
1.	https://www.britannica.com/science/geology/sedimentary-petrology
2.	https://limk.springer.com/chapter/10
3.	https://www.geo.mtu.edu/UPSeis/hazards.html
4.	https://www.omafra.gov.on.ca/english/engineer/facts/
5.	https://geology.com/rocks/rock-salt.shtml

Course Outcomes

CO1: Understand the need and significance of studying disaster management
CO2: Understand the different types of disasters and causes for disasters.
CO3: Gain knowledge on the impacts Disasters on environment and society
CO4: Study and assess vulnerability of a geographical area.
CO5: Students will be equipped with various methods of risk reduction measures and risk mitigation

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

Semester-IV

Mud Logging

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N04	**Mud Logging**	SEC	Y	-	-	-	3	**	00	100	100

Course Objectives

CO1	To Identify and enumerate the methods of drilling. To describe and explain the oil resources. To summarize the whole procedure involved in exploitation of oil resources
CO2	To interpret and select the prospering area for exploitation
CO3	Compare and contrast the differences between prosperous and non-economical sites
CO4	Critically assess and review the ideas at strategic situation at the drilling site
CO5	Can make hypothesis to achieve the target

UNIT	Details	No. of Hrs.	Course Objectives
I	Basics of Mud logging -Surface Logging - Tasks and Responsibilities - Geological Surveillance - Cutting Sampling - Collection, Examination - Lithological and Mineralogical Description- Calcimetry - Oil Shows- Fluorescence and Cut Fluorescence - Chemical Tests - Gas Sampling - Hydrocarbon Gas Analysis - Pore Pressure calculation - Cutting Evaluation - Sample Examination Procedure - Well site Geo- Chemistry- Gases other than Hydrocarbons, Communication Skill - QHSE - Worksite Environmental Hazards - Offshore Safety - Quality Control, MSDS.	12	CO1
II	Mud logging Services, Mud logging Sensors -Operations - Maintenance - Inspection and calibrations-Trouble shooting - Technical Specification - Reporting - Final Well Reports - Mud logging Unit Installation and Maintenance. Lab Training on Rig up and Rig Down of Sensors, Equipment and Monitoring Real time drilling followed by a Rig site visit.	12	CO2
III	Oil Field Drilling - Onshore and Offshore Drilling - Drilling Rigs - Well Types - The Drill String - Drill Bits - Well Profile- Bore-hole volume Calculation and Displacement - Lag time, Lag depth - Basic Hydraulics - Drilling Fluids – Formation Pressure, Bore Hole Problems - Coring - Objective of Coring and Core Analysis- Casing and Cementing- Fishing- Well Completion-Well Testing.	12	CO3
IV	Downhole Measurement - Measuring While Drilling (MWD) - MWD Tools, MWD Principle -Telemetry Types - Formation Evaluation MWD - Sensor information - Natural Gama ray - Formation resistivity - Focused Current Resistivity (FCR) - Toroidal Resistivity - Electromagnetic Wave Propagation Resistivity - Multiple Propagation Resistivity (MPR) - Geosteering- Neutron Porosity, Formation Density - Drilling Performance MWD.	12	CO4
V	Downhole Logging - Logging While Drilling (LWD) - Temperature Logs - Caliper Logs - Self Potential Logs (SP) - Resistivity & Conductivity Logs - Gamma ray and Spectral Gamma ray logs - Sonic Logs - Density and Photo Electric factor Logs - The Neutron Porosity Log - The dip meter-Imaging Logs -MDT Sampling - Lithology reconstruction from Logs- Facies Sequences and depositional environments from Logs - Sequence Stratigraphy.	12	CO5

Text Books

1. Asquith, G., & Krygowski, D., (2004). Basic Well Log Analysis, American Association of Petroleum

	Geologists..
2.	Rider, M. H., & Kennedy, M., (2011). The Geological Interpretation of Well Logs, Rider-French Consulting Ltd.
3.	Serra, O., (2008). Well Logging and Geology, Editions Technip.
4.	Doveton, J. H., (2014). *Principles of Mathematical Petrophysics*, Society of Petrophysicists and Well Log Analysts.
5.	Mitchell, R. F., & Miska, S., (2011). *Fundamentals of Drilling Engineering*, Society of Petroleum Engineers.
6.	Bourgoyne, A. T., et al., (1991). *Applied Drilling Engineering*, Society of Petroleum Engineers.
7.	Schlumberger. (1989). *Log Interpretation Principles/Applications*, Schlumberger Educational Services.
8.	Ellis, D. V., & Singer, J. M., (2007). *Well Logging for Earth Scientists*, Springer.
9.	Catuneanu, O., (2006). *Principles of Sequence Stratigraphy*, Elsevier.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Mudlogging Training Manuals –, Baker Hughes.
2.	Mudlogging Training Manuals –, Geoservices.
3.	The Mud logging Handbook – Alun Whittaker
4.	Mudlogging Training Manuals –, GEOLOG International B.V
Web Resources	
1.	https://www.slb.com/resource-library/oilfield-review/defining-series/defining-mud-logging
2.	https://www.petroskills.com/en/training/courses/mud-logging
3.	https://en.wikipedia.org/wiki/Mud_logging
4.	https://www.drilllabs.com/wp-content/uploads/2016/03/Drill-Labs-Wiki-Mud-Logging.pdf
5.	https://www.jindal.com/jdil/mud-looging-services.html
6.	https://www.sciencedirect.com/topics/engineering/mud-logging
7.	https://oilandgasoverview.com/what-is-mud-logging-in-oil-and-gas/

Course Outcomes

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

Mapping with Programme Outcomes:

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

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

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

Programme Specific Outcomes

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

SUPPORTIVE COURSES (NME-II)

Earth and Environment

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N05	**Earth and Environment**	Supportive	Y	-	-	-	2	4	25	75	100

	Course Objectives
CO1	To explore the fundamental interactions of the geosphere, hydrosphere, atmosphere and biosphere
CO2	The unit is designed to provide a strong scientific foundation for understanding and contextualizing studies of the environment, human impacts and sustainable practice and management of resources
CO3	Describe the connections and feedback between the Earth's spheres
CO4	A basic understanding of the Earth as an holistic system knowledge of the main components of the Earth system and their interactions
CO5	The interactions between biological, chemical, and physical processes that shape and define the Earth System

UNIT	Details	No. of Hrs.	Course Objectives
I	Space Science: Introduction to various branches of Earth Sciences. Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites. Earth Dynamics: Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.	12	CO1
II	Geological Oceanography: Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt.	12	CO2
III	Hydrogeology: Water table- Aquifer- Groundwater fluctuations and groundwater composition, Hydrological cycle. Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier. Petrology - Geological bodies and their structures: Rock, mineral, batholiths, dyke, sill, fold fault, joint, unconformity.	12	CO3
IV	Earth's Atmosphere: Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.	12	CO4
V	Environmental Earth Sciences: Properties of water; hydrological cycle; water resources and management. Energy resources, uses, degradation, alternatives and management; Ecology and Biodiversity. Impact of use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources. Natural hazards. Elements of Remote Sensing.	12	CO5
	Text / Reference Books		
1.	Chapman & Hall, (1992). Holme's Principles of Physical Geology.		

2.	Emiliani, C., (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

Course Outcomes

CO1: The interaction between the Earth's spheres, relevant processes and environmental changes.

CO2: Knowledge and understanding Recapitulate processes in the different spheres

CO3: Describe the connections and feedback between the Earth's spheres Explain the connection between Earth System processes and global environmental changes

CO4: A basic understanding of the Earth as an holistic system knowledge of the main components of the Earth system and their interactions

CO5: The interactions between biological, chemical, and physical processes that shape and define the Earth System

Outcome Mapping

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

Water Resources Management

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N06	**Water Resources Management**	Supportive	Y	-	-	-	2	4	25	75	100

Course Objectives

CO1	To know about the nature and occurrence of water, its spatial and temporal variability, quantity and quality considerations and human influence
CO2	To define the water resources endowment on which development and use of water resources must be planned
CO3	To develop a sound foundation on dynamics of water in the nature and human Interferences
CO4	To develop wider perspectives on integrated water resources management
CO5	To Analyze the human interferences on hydrologic processes and the resulting consequences in terms of quantity and quality

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction: Definition, concepts of watershed, major objectives of watershed management, effects of watershed on community, ecosystem, Monitoring and evaluation of watershed.	12	CO1
II	Principles of watershed management: Delineating the watershed. Natural processes at work in watershed, common elements of watershed management, multidisciplinary approach in watershed management, participatory resources mapping and appraisal, benefits of watershed approach.	12	CO2
III	Degradation agents in watershed: Flood, drought, fire, wind storms, erosion and deposition. Climate change. Glacial movement, Tectonic activity. Volcanic eruption. Human-induced changes. Impact of the degradation of watersheds in hydrology.	12	CO3
IV	Engineering measures for soil conservation: Rainfall parameters. Types of soil erosion. Contour bunding, Surplussing structures contour and straggled trenching, gully control structures, graded bunding, bench terracing, land leveling and grading.	12	CO4
V	Water Conservation and Harvesting: Water conservation methods for crop land, Treatment of catchments. Rainwater harvesting structures: Check dam, farm pond, percolation tank, basin, ditch and furrow, channel, flooding, irrigation, subsurface dyke, Nalla bund and pit methods. Ecosystem assessments, Environmental laws, Future freshwater challenges, Eco tourism, Social and political issues of water use - Sustainable Ecosystems - Environmental Governance.	12	CO5

Text Books

1. Rajora, R., (1998). Integrated Watershed Management, Rewat Publications, New Delhi.
2. Tideman, E.M., (1996). Watershed Management: Guideline for Indian Conditions, Omega, Scientific Publishers, New Delhi.
3. Lal, S., (2004). Watershed, Development, Management and Technology, Mangal Deep Publications.

4.	Paranjape, S. et. al., (1998). Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
5.	Kakade, B.K., (2002). Soil and Water Conservation Structures in Watershed Development Programmes, BAIF Development Research Foundation, Pune.

Course Outcomes

CO1: Appreciate the circulation of water in earth-atmosphere system and the hydrologic processes over a river basin and emerging quality and quantity concerns thereto.

CO2: Quantify the occurrence and variability of rainfall, runoff, flood and sediment transport processes.

CO3: Quantify the occurrence and distribution of groundwater to plan potential groundwater usage.

CO4: Analyze the human interferences on hydrologic processes and the resulting consequences in terms of quantity and quality.

CO5: Analyze Social and political issues of water use Sustainable Ecosystems & Environmental Governance

Outcome Mapping

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

Rainwater Harvesting and Artificial Groundwater Recharge

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N07	**Rainwater Harvesting and Artificial Groundwater Recharge**	Supportive	Y	-	-	-	2	4	25	75	100

Course Objectives	
CO1	To understand the importance of rainwater harvesting for water supply and will learn about different types of rainwater harvesting systems
CO2	To get familiar with different potential uses of rainwater and understand the advantages and limitations
CO3	To get familiar with different components of Groundwater management strategy
CO4	To make them understand about the Artificial groundwater recharge structures
CO5	To understand and explain the main quality concerns with respect to BIS and WHO standards

UNIT	Details	No. of Hrs.	Course Objectives
I	Hydrological cycle and its components. Surface water and groundwater. Vertical distribution of groundwater. Over- exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dug, bore and tube wells.	12	CO1
II	Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge bore wells. Rainwater harvesting in urban areas: RWH structures - design - construction.	12	CO2
III	Estimation of probable runoff from an area including from rooftops - maintenance and monitoring of RWH structures - benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water to recharge in urban areas. Aquifer and its types.	12	CO3
IV	Water table and its fluctuations. Water quality parameters. BIS and WHO standards. watershed management strategy. Salt water intrusion and remedial measures. Interlinking of rivers in India. Indian monsoon pattern. Role of meteorological department. Integrated Water Resources Management (IWRM) Approach: IWRM Principles: Modern principles for water management and planning, definition, components, and critique of IWRM.	12	CO4
V	Groundwater management strategy, recycling of effluent water, sources of water contamination and remedial measures. Impact of urbanization on water resources. Definition for river basin, sub basin, watershed and micro watershed. Role of public in watershed management practices at village level. Sustainable Water Resources Management: Concept of sustainable development, sustainability principles for water management, goals for guiding sustainable water resource management.	12	CO5
	Text Books		
1.	Rajora, R., (1998). Integrated Watershed Management, Rewat Publications, New Delhi.		

2.	Lal, S., (2004). Watershed, Development, Management and Technology, Mangal Deep Publications.
3.	Paranjape, S. et.al., (1998). Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
4.	Suresh.R., (2002). Soil and Water Conservation Engineering, Standard Publishers and Distributers, Delhi.
5.	Kakade, B.K., (2002). Soil and Water Conservation Structures in Watershed Development Programmes, BAIF Development Research Foundation, Pune.

Course Outcomes

CO1: Understands different potential uses of rainwater advantages and limitations.
CO2: Students get a exposure of different components of Groundwater management strategy
CO3: Learned about the potential of rainwater harvesting under different circumstances
CO4: To have preliminary ideas pertaining to watershed development and management strategies.
CO5: Enhance the distribution and movements of groundwater resources on global scenario

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	3	2	3	2	1	3	2	1	1
CO 2	3	1	2	3	2	3	1	1	2	2	2	1
CO 3	3	2	1	3	2	3	1	3	3	1	1	1
CO 4	3	2	1	3	2	3	2	2	3	2	1	1
CO 5	3	2	1	3	2	3	2	2	2	2	1	1

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

Programme Specific Outcomes

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

Geohazards

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1N08	**Geohazards**	Supportive	Y	-	-	-	2	4	25	75	100

Course Objectives	
CO1	To explain students about the physical and geological processes causing geohazards
CO2	To discuss the methods for quantifying geohazards
CO3	To understand the possible consequences as well as risk and disaster management
CO4	To make them aware about landslides, floods, tsunamis and earthquakes, for which the geological and physical process were to be discussed
CO5	To discuss potential, inter linkages between different types of geohazards, disaster prevention and management and quantification and communication of uncertainties

UNIT	Details	No. of Hrs.	Course Objectives
I	Natural Hazard - definition -Earth's processes: catastrophic geological hazards: study of floods, tsunamis, Landslides, Earthquakes, Volcanism and avalanches - with a view to assess the magnitude of the problem, prediction and perception of the hazards. Laws and regulations towards hazard management.	12	CO1
II	Earthquakes-Definition -focus -epicenter-seismic waves-intensity and magnitude- Richter scales - Tsunami -Seismograph- seismogram-seismicity in Indian region - Seismic gaps - mitigation measures and management. Preparation of seismic hazard map- Seismic Gap.	12	CO2
II	Volcanoes-Definition-structure - types -Global distribution - mitigation measures and management. Avalanche - Definition - types - mitigation. Flood- Definition - causes - vulnerable zones in India- Mitigation measures and management. Monitoring and prediction of eruptions: short term, long term. Coastal erosion - its causes-mitigation measures and management.	12	CO3
IV	Landslides- types -slow flowage, rapid flowage, sliding and subsidence - causes and mechanism - Vulnerable zones in India - mitigation measures and management. Deforestation and land degradation- Cyclone- Definition -causes - vulnerable zones in India-mitigation measures and management. Weather, temperature and pressure differences, trade and westerly winds, adiabatic cooling, cold and warm fronts.	12	CO4
V	Mass movement - factor influencing slope stability - types of mass movement - hazards of mass movement - strategies for their reduction and the role of geology. Soil erosion - Soil formation - soil classification - factor influencing soil erosion - hazards of soil erosion - Drought - types, mitigation measures. Waves, beaches, coastal erosion: wave characteristics, summer and winter beaches, wave refraction and longshore drift; sand supply and cliff erosion.	12	CO5

	Text/ Reference Books
1.	Valdiya, K.S., (2004). Geology, environment, Society Universities Press (India) Private Limited, Hyderabad, India.

2.	Valdiya, K.S., (2004). Coping with Natural hazards: Indian context Orient Longman Private Limited, Hyderabad, India.
3.	Parbin Singh, (2003). Engineering and General Geology, S.K.Kataria and sons Delhi India.
4.	Radhakrishnan, V., (1996). General Geology, V.V.P.Publishers, Tuticorin, India.
5.	Lundgren, (1986). Environment Geology, Prentice Hall Publishers, New Jersey.
6.	Ramkumar, M., (2009). Geological hazards: Causes, Consequences and methods of Containment. New India Publishers, New Delhi.

Course Outcomes

CO1: Explain the physical and geological processes causing geohazards such as landslides, floods, tsunamis and earthquakes.

CO2: Describe methods for quantifying hazard for the individual geohazards and factors controlling their uncertainty.

CO3: Explain possible consequences of geohazards as well as risk and disaster management.

CO4: Complete a basic hazard assessment for selected geohazards.

CO5: Gain an additional knowledge on possible interactions between geohazards and their consequences

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

VALUE ADDED COURSES
(CERTIFICATE COURSE - EXTRA CREDITS)
Semester-III
Peace Education

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1VA1	**Peace Education**	Value Added Courses	Y	-	-	-	2	-	25	75	100

Course Objectives		
CO1	Understand the importance of Peace	Understand
CO2	Explain how to recover the state of Peace	Understand
CO3	Internalize and Practice the Value of Peace	Apply
CO4	Understand sustainable Peace and the role of oneself	Understand
CO5	Become the paper messenger who spreads the culture of Pease	Apply

UNIT	Details	No. of Hrs.	Course Objectives
I	**Introduction to Peace Education and HWPL:** Aims and objectives of Peace Education- Development of Peace work of HWPL- Making groups for assignments- Rapporbuilling.	12	CO1
II	**Finding Peace and me:** Diversity- Harmony- Original State of All creation- Connectivity- Value- Role- Duty- Interpersonal relationship- Greed- Love- Order.	12	CO2
III	**Peace Values:** Gratitude- Consideration- Sacrifice- Understanding- Forgiveness- Respect for Parents, Teachers and Peace- Scripture- Culture sphere.	12	CO3
IV	**Peace Citizen:** Heritage- World Peace- Great legacy; a case of Peace- Law- Law- abiding Sprit- Treaty- DPCW-NGO; HWPL- Peace Citizen- Courage- Peace- Loving Heart- Messenger of Peace.	12	CO4
V	**Peace Messenger:** Peace Messenger- Peace Experience - Will for Peace.	12	CO5

	Tasks and Assignments
1.	Writing an Essay on World Peace and Gratitude
2.	Engaging in debates on topics related to Peace
3	Group Project for practicing Peace Values
4	Group Project to promote the importance of Peace

References Books	
1.	https://www.un.org/en/
2.	https://www.yputube.com/watch?v=i 8 lhBZe6Sn4
3.	https.//www.hwpl.kr/language/en/home-hwpl-en/
4.	Heavenly Culture World Peace Restoration of Light, (2022). Road to Peace
5.	Oh lk-soo (1996), Youth Group Counseling

Mapping with Programme Outcomes:

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

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

Hydrology and Water Management

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1VA2	**Hydrology and Water Management**	Value Added Courses	Y	-	-	-	2	30	25	75	100

Course Objectives	
CO1	To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth
CO2	To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain
CO3	To understand the physical, chemical and biological characteristics of water with special emphasis on pollution and contamination
CO4	To understand the relationship in between water and rock interaction and saltwater intrusion and its remedial measures in the coastal aquifers
CO5	An ability to ethical, social, health and sustainable consumption of water resources

UNIT	Details	No. of Hrs.	Course Objectives
I	Introduction to Groundwater, Hydro meteorology, Groundwater in Hydrologic Cycle, Occurrence of groundwater, zone of Aeration and Saturation, Hydrogeology, Types of aquifers soil sample analysis - Water bearing materials, Aquifer parameters and its determination. Evaporation and its measurement- Evapotranspiration and its measurement- Perman Montieth method-Infiltration- Factors affection infiltration-Hyetograph- Runoff- drainage basin characteristics-Hydrograph concepts assumptions and limitations of unit hydrograph.	12	CO1
II	Occurrence and movement of groundwater- Darcy's law-governing ground water flow equations-Factors governing ground water flow-Types of aquifers- porosity- specific yield specific retention - storage coefficient-permeability- hydraulic conductivity- hydraulic transmissibility-Conjunctive use and its necessity. Types of Investigations- Site selection- Zones of storage - Safe yield-Reservoir capacity- Reservoir sedimentation and control.	12	CO2
III	Indian rivers and floods- Causes of flooding- Alleviation- Leeves and flood walls Floodways-Channel improvement- Flood damage analysis-Design flood- Flood estimation- Frequency analysis- Flood routing through reservoirs and open channels- Storm drainage design.	12	CO3
IV	Definition of drought- Causes of drought- measures for water conservation an augmentation-drought contingency planning-Water harvesting: rainwater collection-small dams-runoff enhancement-runoff collection- ponds- tanks- natural and artificial ground water recharge methods	12	CO4
V	Introduction - Components of Hydroelectric Power Plant-Levels in planning-Functional requirements of water resources projects-steps in water resources planning- Environmental aspects in water resources planning	12	CO5

	Text / Reference Books
1.	Garg S.K., Hydrology and Water Resources Engineering
2.	Subramanya, K., Engineering Hydrology, Tata McGraw Hill, New Delhi.
3.	Raghunath, H.M., Groundwater, (1987). Wiley Eastern Ltd., New Delhi.

4.	Modi, P.N., Irrigation Water Resources and Water Power Engineering, Standard Book House, New Delhi
5.	Todd, D.K., (1993). Groundwater Hydrology, John Wiley & Sons.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Raghunath, H.M., (1986). Hydrology - Principles, Analysis and Design.
2.	Dr. P.Jaya Rami Reddy, A Textbook of Hydrology, University Science Press.

Course Outcomes

CO1: Capable of understanding the impact of water conservation methods in regional and national context.

CO2: An ability to understand the importance of groundwater augmentation strategies.

CO3: To perform socio economic analysis to evaluate the intangible benefits of artificial structures.

CO4: Formulate and solve deterministic and optimization models for water resources.

CO5: To get familiarization of principles and applications of various groundwater exploration techniques

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

Environmental Studies and Earth Sciences

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1VA3	**Environmental Studies and Earth Sciences**	Value Added Courses	Y	-	-	-	2	30	25	75	100

Course Objectives

CO1	To learn the fundamental components of hydrological cycle and distribution of fresh and salt water of the Earth
CO2	To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain
CO3	To understand the physical, chemical and biological characteristics of water with special emphasis on pollution and contamination
CO4	To understand the relationship in between water and rock interaction and salt water intrusion and its remedial measures in the coastal aquifers
CO5	An ability to ethical, social, health and sustainable consumption of water resources

UNIT	Details	No. of Hrs.	Course Objectives
I	Renewable and non-renewable resources: Natural resources and associated problems-Forest resources: deforestation- Timber extraction, mining, dams and their effects on forest -Water resources - Use and over-utilization of surface and groundwater- floods- Energy resources - Growing energy needs-renewable and nonrenewable-energy sources-use of alternate energy sources- man induced landslides-desertification- Human Settlements and their impact on Environment.	12	CO1
II	Structure and function of an ecosystem- Principles of Ecology: Composition and various Types of Ecosystem – Ecological Succession-Food chains-food webs and ecological pyramids- Introduction-types-characteristic features- structure and function of the Forest Ecosystem-Grassland Ecosystem-Desert ecosystem- Aquatic ecosystems	12	CO2
III	Definition-Cause effects and control measures of Air pollution- Water Pollution-Soil Pollution-Marine Pollution-Noise pollution- Thermal Pollution-Nuclear Hazards-Solid waste Management - Causes- effects and control measures of urban and Industrial Wastes-Disaster Management -floods- earthquake- cyclone and landslides. National and Global Environmental Issues. Environmental Impact Assessment (EIA), general guidelines for the preparation of environmental impact statement (EIS), scope and types of environmental audit, cost benefit analysis, environmental management plan (EMP), international organization for standardization (ISO).	12	CO3
IV	Mechanical layering of the Earth-lithosphere- asthenosphere-mantle and core-Earthquake and earthquake belts: seismic waves and internal constitution of the Earth-Volcanoes and volcanism-distribution of volcanoes-Concept of Isostasy, Formation of core-mantle- crust- atmosphere-hydrosphere and biosphere-Convection in Earth's core.	12	CO4
V	Origin and Age of the Earth, Historical development of the concept of continental drift and plate tectonics-Plates and plate boundaries-Geodynamic elements of Earth- mid oceanic ridges- trenches-transform faults and island arcs-Plate tectonics- mountain belts and rift valleys.	12	CO5

	Text Books
1.	Agarwal, K.C., (2001). Environmental Biology, Nidi Publ. Ltd. Bikaner. Bharucha Erach, The Biodiversity of India, Map in Publishing Pvt. Ltd., Ahmedabad - 380 013, India.
2.	Brunner R.C., (1989). Hazardous Waste Incineration, McGraw Hill Inc. 480p Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).
3.	Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., (2001). Environmental Encyclopedia, Jaico Publ. House, Mumbai.
4.	Gleick, H.P., (1993). Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.
5.	Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R).
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Heywood, V.H & Waston, R.T., (1995). Global Biodiversity Assessment Cambridge Univ. Press.
2.	Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB).
3.	Odum, E.P., (1971). Fundamentals of Ecology. W.B. Saunders Co. USA.
4.	Duff, P. M. D., and Duff, D., (1993). Holmes' principles of physical geology. Taylor and Francis.
5.	Emiliani, C., (1992). Planet Earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

Course Outcomes

CO1: Capable of understanding the Renewable and Non-Renewable resources.
CO2: An ability to understand the importance of ecosystem strategies.
CO3: Complete a basic hazard assessment for selected geohazards.
CO4: Basic knowledge about the internal structure of the Earth.
CO5: Understand the plate tectonics theory and its local-global scale implications.

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	1	1	2	3	2	1	2	2	1	1
CO 2	3	2	1	1	2	3	2	1	2	2	1	1
CO 3	3	2	1	1	2	3	2	2	3	2	2	1
CO 4	3	2	1	1	2	3	1	2	2	2	1	1
CO 5	3	2	1	1	2	3	2	2	2	1	2	1

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

Programme Specific Outcomes

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

ADD ON COURSES

Medical Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1AO1	**Medical Geology**	Add On Courses	Y	-	-	-	2	30	25	75	100

Course Objectives

CO1	The geochemistry of the environments has a marked influence on their health, giving rise to diseases that affect millions of people
CO2	To expose the students on the interaction of Human beings with the geochemistry of the earth environment
CO3	To learn the fundamental components of Medical Geology
CO4	To Capable of understanding the impact of health due to water borne diseases
CO5	To perform socio economic analysis to evaluate the intangible benefits of artificial structures

UNIT	Details	No. of Hrs.	Course Objectives
I	General characteristics of tropical, subtropical environments, arid zone, seasonally dry tropics and sub-tropics, humid tropics, and sub-tropics zone and mountainous zone. Rock weathering and soil formation, weathering of mineralized terrains, weathering profiles. Weathering and formation of secondary minerals. Chemistry of weathering of ultra-basic rocks.	12	CO1
II	Medical Geology- Perspectives and Prospects, Public Health and Geological Processes: An Overview of a Fundamental Relationship. Environmental Biology-Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements on Chemical and Biological Perspective and its functions, Geological Impacts on Nutrition.	12	CO2
III	Pathways and Exposure- Volcanic Emissions and Health, Radon in Air and Water, Arsenic in Groundwater and the Environment. WHO and BIS Standards for drinking water. Fluoride in Natural Waters, soils, sediments, plants. Fluorides and health: Bioavailability of fluoride, Dental fluorosis, Skeletal fluorosis, Dental fluorosis in India, source, nature, cause and extent. Water Hardness and Health Effects, Geochemical basis for tropical Endomyocardial fibrosis (EMF), Effect of water hardness on urinary stone formation. Types of stones: Calcium oxalate, Calcium phosphate, Uric acid, Magnesium ammonium phosphate stones, Cysteine.	12	CO3
IV	Iodine and health: The iodine cycle in the environment, Iodine in drinking water, Iodine in food, Iodine Deficiency Disorders (IDD), Endemic cretinism, Goitrogens. The nitrogen cycle, Nitrate as fertilizers and environment, Nitrogen loading in rice fields, Nitrates from human and animal wastes, Nitrates and health, Nitrates and Methemoglobinemia, Nitrates and cancer. Bioavailability of Elements in Soil, Selenium Deficiency and Toxicity in the Environment, Soils and Iodine Deficiency, Natural Aerosolic Mineral Dusts and Human Health, Animals and Medical Geology. The Impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.	12	CO4

V	Environmental Toxicology, Environmental Epidemiology, Environmental Medicine, Environmental Pathology, Speciation of Trace Elements. Techniques and Tools GIS in Human Health Studies, Investigating Vector-Borne and Zoonotic Diseases with Remote Sensing and GIS. Mineralogy of Bones, Inorganic and Organic Geochemistry Techniques, Histochemical and Microprobe Analysis in Medical Geology.	12	CO5
	Text / Reference Books		
1.	Dissanayake, C.B., and Chandrajith, R., (2009). Introduction to Medical Geology, Springer, London.		
2.	Catherine, H., Skinner, W., Antony R. Berger, (2003). Geology and Health: Closing gap, Oxford Univ. press, New York.		
3.	Iosif F. Volfson, (2010). Medical Geology: Current Status and Perspectives, Russian Geological Society (ROSGEO) Publisher. Moscow.		
4.	Valdiya, K.S., (2004). Geology, environment, Society, University press (India), Hyderabad.		
5.	Lawrence K. Wang, et al., (2009). Heavy Metals in the Environment, CRS Press, Taylor & Francis Group, Boca Raton, FL.		

Course Outcomes

CO1: Capable of understanding the impact of health due to water borne diseases.
CO2: An ability to understand the importance of Pathways and Exposure.
CO3: To perform socio economic analysis to evaluate the intangible benefits of artificial structures.
CO4: The study of the Agricultural, Soil and Crops on the Nutritional Health of Humans.
CO5: To get familiarization of principles and applications of Microprobe Analysis in Medical Geology

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

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

Programme Specific Outcomes

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

Petroleum Geology

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1AO2	**Petroleum Geology**	Add On Courses	Y	-	-	-	2	30	25	75	100

Course Objectives	
CO1	To solving technical challenges connected to the development and production of hydrocarbon reservoirs on a regional to reservoir scale
CO2	Petroleum is one of the most important resources of energy therefore the basic understanding of petroleum is important
CO3	To understand the concept of petroleum system
CO4	To understand the Geographic and Stratigraphic distributions of oil and gas
CO5	An ability to infer the Petroleum economics, production and development

UNIT	Details	No. of Hrs.	Course Objectives
I	Physical and Chemical Properties of Petroleum Origin and composition of petroleum and natural gas, source rocks, reservoir rocks and traps. Migration and accumulation of oil and gas. Introduction to Petroleum Geology, History of Petroleum, Energy Resources, Renewable Energy, Non-Renewable Energy, fossil Fuels.	12	CO1
II	Concept of petroleum system. Reservoir rocks clastic and non- clastic reservoir rocks, development and types of porosity in these rocks. Controls of permeability. Types of petroliferous basins and their relation to hydrocarbon potential Generation of Petroleum, Migration of Petroleum: primary and secondary; Reservoir Characteristics: Porosity and permeability.	12	CO2
III	Geographic and stratigraphic distributions of oil and gas. Methods and techniques for petroleum exploration, Surface indications and direct detection of hydrocarbons Subsurface Environments. Source Rock Origins, Hydrocarbon Traps: Structural Traps, Stratigraphic traps, hydrodynamic traps; Combination traps, Oil Exploration, Application of microfossils in petroleum.	12	CO3
IV	Sub-surface geological methods and brief idea about geologic interpretations of seismic data. Drilling methods, drilling equipment's, drilling fluids, well-logs. Exploration Methods Reservoirs, Traps and Seals Nonconventional Petroleum Resources Sedimentary Basins and Petroleum Systems Well logging: SP log, Gamma Log, Sonic log, gas drive, gas cap drive, gas hydrate.	12	CO4
V	Estimation of reserves and resources. Petroleum economics, production and development geology. Petroleum traps. Cap rocks (seals). Occurrence, surface indications and direct detection of hydrocarbons. Petroleum habitats. An outline of the oil belts of the world Oil producing basins of India: Assam, Krishna-Godavari, Bombay, Cambay, and Rajasthan.	12	CO5
	Text / Reference Books		

1.	Tissot, B.P. and Welte, D.H., (1984). Petroleum Formation and Occurrence, Springer-Verlag, Berlin, 2nd Edition.
2.	North, F.K., (1985). Petroleum Geology, Allen &Unwin, London.
3.	Hunt, J.M., (1996). Petroleum Geochemistry and Geology, W.H. Freeman, San Fransisco, 2nd Edition.
4.	Sahay, B., Rai, A. and Ghosh, M., (1984). Wellsite Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi.
5.	Selley, R.C., (1997). Elements of Petroleum Geology, Academic Press, London, 2nd Edition.

Course Outcomes

CO1: Capable of understanding the Renewable and Non-Renewable Energy.

CO2: An ability to understand the importance of hydrocarbon potential generation of Petroleum.

CO3: To perform Petroleum source rock origins, Hydrocarbon Traps.

CO4: Formulate and solve deterministic and optimization models of Petroleum Resources Sedimentary Basins.

CO5: To get familiarization of principles and applications of estimation of reserves and resources.

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

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

Programme Specific Outcomes

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

Groundwater Exploration

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
25UPGEO1AO3	**Groundwater Exploration**	Add On Courses	Y	-	-	-	2	30	25	75	100

Course Objectives	
CO1	To learn the fundamental components of hydrology and basin characteristics
CO2	To impart theoretical, practical and field knowledge pertaining to Hydrogeological domain
CO3	To understand the subsurface methods of groundwater exploration
CO4	To interpret the conditions of water resources and to select some areas where the groundwater is being exploited against the natural laws
CO5	To critically assess different factors/aspects involve

UNIT	Details	No. of Hrs.	Course Objectives
I	Renewable resource Renewable resource, Hydrology and basin characteristics, run-off and stream flow, aquifer characteristics, geology of groundwater occurrence, trans-boundary aquifers, groundwater quality, saline water intrusion.	12	CO1
II	Esoteric method: Water divining, Soil and Micro-Biological Methods Biophysical.	12	CO2
III	Surface investigation: Geologic method, geomorphological method, hydrogeological method, electrical resistivity method, Vertical electrical sounding. Profiling, Wenner and Schlumberger array, Dipole-dipole array, Interpretation of data, electromagnetic method, seismic method, gravity and magnetic method, geobotanical methods, geochemical methods.	12	CO3
IV	Subsurface methods: test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration, tracer techniques.	12	CO4
V	Aerial method, Photo geology, Landsat / IRS Infrared imagery, Electromagnetic techniques. Remote sensing methods, artificial recharge, groundwater modeling, groundwater law, watershed management.	12	CO5

	Text / Reference Books
1.	Davies, S.N. and De Wiest, D.R., (1966). Hydrogeology-John Wiley& sons, Inc, New York.
2.	Fetter, C.W., (1990). Applied Hydrogeology-McGraw Hill, Publisher, New Delhi.
3.	Handa, O.P., (1984). Groundwater Drilling, Oxford & I.B.H. Publishing Co.
4.	Hiscock, K., (2005). Hydrogeology, Principles and Practice, Blackwell Publishing.
5.	Karanth, K.R., (1987). Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi.

Course Outcomes

CO1: Capable of understanding the impact of water conservation methods.
CO2: An ability to understand the importance of groundwater augmentation strategies.
CO3:To get familiarization of principles and applications of various groundwater exploration techniques
CO4: Occurrence and movement of Groundwater
CO5: Groundwater wells, types and methods

Outcome Mapping

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

	PO1	***PO2***	***PO3***	***PO4***	***PO5***	***PSO1***	***PSO2***	***PSO3***	***PSO4***	***PSO5***	***PSO6***	***PSO7***
CO 1	3	2	2	3	3	3	1	2	3	2	2	1
CO 2	3	3	2	2	3	3	3	2	2	2	1	1
CO 3	3	2	2	2	3	3	2	2	3	1	1	1
CO 4	3	3	2	2	3	3	2	2	2	1	2	2
CO 5	3	2	2	1	3	3	2	2	3	2	2	1

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

Programme Specific Outcomes

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