MANONMANIAM SUNDARANAR UNIVERSITY

Tirunelveli - 627012, Tamil Nadu, India

STRUCTURE AND DETAILED SYLLABUS

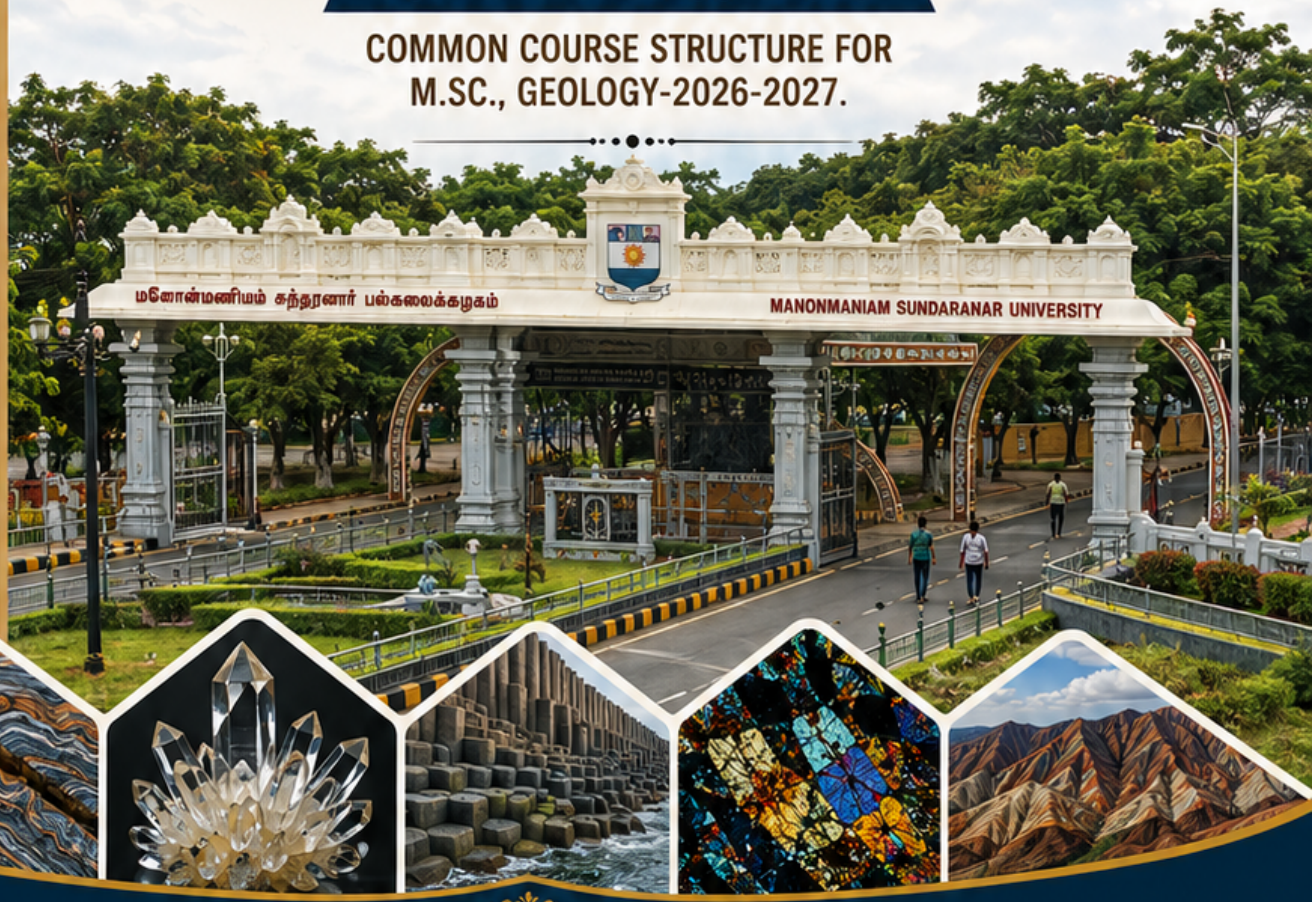
POSTGRADUATE COURSE (M.Sc.)

IN GEOLOGY

LEARNING OUTCOME BASED CURRICULUM
(CHOICE BASED CREDIT SYSTEM)

FOR AFFILIATED COLLEGES

COMMON COURSE STRUCTURE FOR
M.SC., GEOLOGY-2026-2027.



MANONMANIAM SUNDARANAR UNIVERSITY
Tirunelveli - 627012, Tamil Nadu, India

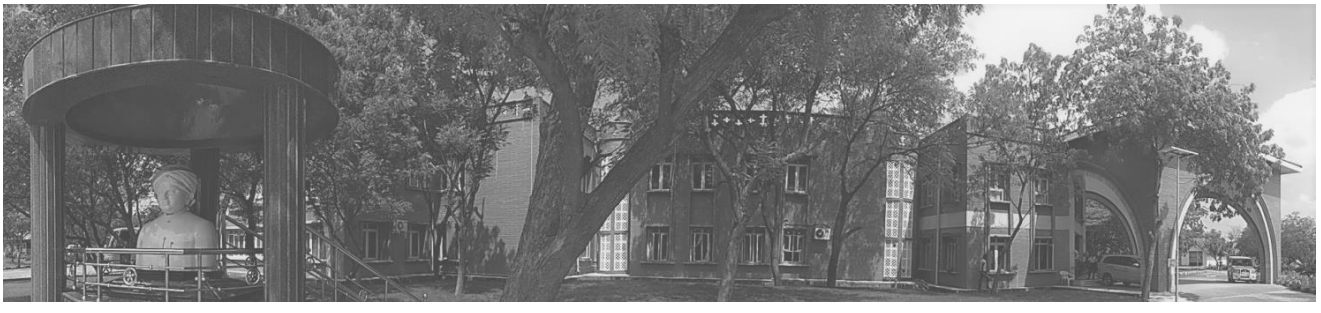
STRUCTURE AND DETAILED SYLLABUS POSTGRADUATE COURSE (M.SC.) IN GEOLOGY, LEARNING OUTCOME BASED CURRICULUM (CHOICE BASED CREDIT SYSTEM)

FOR AFFILIATED COLLEGES

COMMON COURSE STRUCTURE FOR M.SC., GEOLOGY

MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI- 627012



2026-207

OUTCOME BASED EDUCATION - CHOICE BASED CREDIT SYSTEM

1. UNIVERSITY VISION

"To provide quality education to reach the un-reached"

2. UNIVERSITY MISSION

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled.

3. PREAMBLE

Outcome Based Education (OBE) is the order of the day in all Higher Education Institutions to emphasize quality mandate. Curriculum tailored with Choice Based Credit System (CBCS) for ensuring flexibility; Exposure to learning opportunities using the latest technological advancements to the learners for continuous lifelong learning; and Adoption of Revised Bloom's Taxonomy (RBT) in the assessment mechanism are essential to add value to the existing OBE. The current revision is aimed at providing scope for effective implementation of OBE by including Programme Educational Outcomes, Programme Outcomes, and Programme Specific Outcomes in alignment to the vision and mission of the University. Courses need to be framed and mapped such that the compilation of the Outcomes of all Courses in the programme ensures the attainment of the programme outcomes in terms of RBT.

4. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

In alignment with the Vision and Mission of the University, the following have been defined as the PEO for the graduates.

PEO1: Developing strong positive attitude to learn independently the concepts in the field of study

PEO2: Ensuring confidence among the learners to apply the knowledge and skills gained to solve real life issues

PEO3: Habituating ethical values among the learners to succeed in personal and professional life

5. PROGRAMME OUTCOMES (POs)

Programme Outcomes for the Under Graduate Degree Programmes of the University are articulated as under.

After the successful completion of Undergraduate Programme from the University, the learner should be able to

PO1: Comprehend the knowledge acquired and communicate the same to others

PO2: Analyze and compare the factual data / situation to comprehend and to critically evaluate to find solution to the problem ahead

PO3: Apply theories and philosophies learned in solving the problem in scientific manner

PO4: Think reflectively on the earlier activities and attempt for self-directed lifelong learning process

PO5: Understand multicultural existence and identify the means to prolong moral/ethical values in personal and professional life

PO6: Expose the learner to the digital technology to learn through multiple sources

PO7: Train the learner to be a responsible player in teams and impart leadership qualities in them.

6. PROGRAMME SPECIFIC OUTCOMES (PSO)

On completion of the programmed, graduates will be able to:

PSO1: Disciplinary Knowledge

Apply fundamental and theoretical knowledge of mathematics, including algebra, analysis, geometry, and statistics, to support higher studies, research, and innovation.

PSO2: Critical Thinking

Analyze mathematical problems critically and evaluate appropriate methods and solutions in academic, industrial, and societal contexts.

PSO3: Problem Solving

Solve mathematical and real-life problems using logical reasoning, analytical thinking, and computational techniques.

PSO4: Analytical Reasoning

Interpret data and mathematical models using quantitative techniques to address scientific and sustainability-related challenges.

PSO5: Research Skills

Demonstrate basic research aptitude by formulating problems, collecting and analyzing data, and presenting findings effectively.

PSO6: Self-directed Learning

Engage in lifelong learning and adapt to advancements in mathematics, science, and technology.

PSO7: Employability and Entrepreneurship

Develop skills for employability, entrepreneurship, and career readiness in industry, education, and technology-driven sectors.

Each Course has to address a minimum of 4 PSOs

Level of contribution of the Course towards attaining PSOs

0 – No Contribution 1 – Low Level 2 – Medium Level 3 – High Level

S.No.	Course Title	Summarized PSO Title
1	Physical Geology and Geomorphology	Earth Processes and Surface Landform Evolution
2	Mineralogy and Instrumentation Techniques	Mineral Characterization and Analytical Techniques
3	Practical: Mineralogy and Instrumentation Techniques & Paleontology	Mineral, Fossil Identification and Laboratory Skills
4	Stratigraphy of India and its Application (Mandatory)	Stratigraphic Framework and Geological Correlation
5	Recent Trends in Paleontology	Evolutionary Studies and Modern Paleontological Applications

6	Urban Geology (Optional)	Urban Planning, Engineering and Environmental Geology
7	Structural Geology and Geotectonics	Rock Deformation, Structural Analysis and Tectonics
8	Igneous and Metamorphic Petrology	Petrogenesis and Metamorphic Processes
9	Practical: Structural Geology and Geotectonics and Petrology	Structural Interpretation and Rock Analysis Skills
10	Sedimentary Petrology (Mandatory)	Sedimentary Processes, Basin Analysis and Provenance Studies
11	Environmental Earth Science	Environmental Management and Sustainable Earth Resources
12	Isotope Geology (Optional)	Isotopic Applications in Geology and Geochronology
13	Oceanography and Climatology	Ocean–Atmosphere Dynamics and Climate Systems

Course Title	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**Total Score**
Physical Geology and Geomorphology	3	3	3	3	2	2	1	17
Mineralogy and Instrumentation Techniques	3	3	3	3	2	2	1	17
Practical: Mineralogy and Instrumentation Techniques & Paleontology	3	3	3	3	2	2	1	17
Stratigraphy of India and its Application (Mandatory)	3	3	3	3	2	2	1	17
Recent Trends in Paleontology (Optional)	3	3	3	3	2	2	1	17
Urban Geology (Optional)	3	3	3	3	2	2	1	17
Structural Geology and Geotectonics	3	3	3	3	2	2	1	17
Igneous and Metamorphic Petrology	3	3	3	3	2	2	1	17
Practical: Structural Geology and Geotectonics and Petrology	3	3	3	3	2	2	1	17
Sedimentary Petrology (Mandatory)	3	3	3	3	2	2	1	17
Environmental Earth Science (Optional)	3	3	3	3	2	2	1	17

Isotope Geology (Optional)	3	3	3	3	2	2	1	17
Oceanography and Climatology	3	3	3	3	2	2	1	17

7. PROGRAMME DETAILS

Programme	**M.Sc. GEOLOGY**
Eligibility	Bachelor of Science (B.Sc.) degree in Geology, Earth Science, or Applied Geology with 50-60% aggregate marks from a recognized university.
Medium of Instruction	English
Duration:	2 Years (PG)

8. EXAMINATION SCHEME

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	**25 Marks (Theory)** **50 (Practical)**
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	**75 Marks (Theory)** **50 (Practical)**
	Total	**100 Marks**
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions.	
Understand/Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or Overview.	
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain.	
Analyze(K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge.	
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons.	
Create (K6)	Check knowledge in specific or offbeat situations, discussion, debating or Presentations.	

Passing Minimum

The candidate shall be declared to have passed the examination if the **candidates secure not less than 38 marks out of 75 marks in the semester examination** in each theory course and in total (CIA mark + Theory Exam mark) not less than 50 marks.

The candidates shall be declared to have passed the examination if he/she secures not less than 50 marks in total (CIA mark + Practical Exam mark) with minimum of **25 marks out of 50 marks in the Practical Exam** conducted by the University. **There is no passing minimum for the internal exam.**

Candidate who does not obtain the required minimum marks for a pass in a Course/Practical shall be declared Re-Appear (RA) and the candidate has to appear and pass the same at a subsequent appearance.

9. QUESTION PAPER PATTERN

Semester End Examinations (75 Marks)

Note: In both Internal and Semester End Examinations

For PG - Lower Order Thinking (K1, K2, & K3) – 40 % in each part

Higher Order Thinking (K4, K5, & K6) – 60 % in each part

PART – A Choose the correct answer	(15 × 1 = 15)
PART – B Answer ALL Questions. Choosing either (a) or (b)	(5 × 4 = 20)
PART – C Answer ALL Questions. Choosing either (a) or (b)	(5 × 8 = 40)

10. MODEL QUESTION PAPER

MANONMANIAM SUNDARANAR UNIVERSITY

M.Sc. Degree Examination – Geology

PHYSICAL GEOLOGY AND GEOMORPHOLOGY

Time: 3 Hours **Maximum Marks: 75**

PART – A (15 × 1 = 15)

Choose the correct answer

1. The discontinuity separating the crust and mantle is known as
   a) Gutenberg discontinuity
   b) Conrad discontinuity
   c) Mohorovicic discontinuity
   d) Lehmann discontinuity
   (K1)
2. The asthenosphere is characterized by
   a) Completely solid and rigid rocks

b) Plastic and partially molten materials

c) Absence of convection currents

d) Sedimentary layering

(K2)

3. Oceanic trenches are mainly associated with

   a) Divergent boundaries

   b) Transform boundaries

   c) Convergent boundaries

   d) Passive margins

   (K2)

4. Palaeomagnetism is primarily useful in determining

   a) Present magnetic intensity

   b) Paleo position of continents

   c) Mineral composition of rocks

   d) Age of fossils

   (K3)

5. Isostatic adjustment mainly occurs due to

   a) Uniform sedimentation

   b) Balance between crust and mantle

   c) Increase in volcanic eruptions

   d) Atmospheric pressure changes

   (K4)

6. Orogeny refers to

   a) Formation of plains

   b) Mountain-building processes

   c) Coastal erosion

   d) Soil formation

   (K1)

7. Geomorphology mainly deals with the study of

   a) Minerals only

   b) Earth’s magnetic field

   c) Evolution of landforms

   d) Fossil succession

   (K1)

8. Seismic belts are commonly concentrated along
   a) Stable continental shields
   b) Plate boundaries
   c) River valleys
   d) Desert margins
   (K2)
9. The Circum-Pacific belt is well known for
   a) Low seismicity
   b) Major earthquake activity
   c) Absence of volcanoes
   d) Lack of tectonic movement
   (K3)
10. Geodesy is concerned with
   a) Study of fossils
   b) Measurement of Earth's shape and dimensions
   c) Study of volcanoes
   d) Groundwater movement
   (K2)
11. Pedogenesis refers to
   a) River erosion
   b) Soil formation processes
   c) Glacier movement
   d) Coastal sedimentation
   (K1)
12. Mass movement is mainly controlled by
   a) Solar radiation alone
   b) Gravitational force
   c) Ocean currents
   d) Earth's magnetism
   (K2)

13. Yardangs are landforms typically produced by
   a) Glacial erosion
   b) River deposition

c) Wind erosion

d) Marine action

(K3)

14. Karst topography develops predominantly in

a) Granite terrains

b) Basaltic rocks

c) Limestone regions

d) Sandstone formations

(K4)

15. Quaternary landscapes are significant for understanding

a) Precambrian tectonics only

b) Recent climatic and geomorphic evolution

c) Deep mantle processes

d) Origin of the solar system

(K5)

PART – B (5 × 4 = 20)

Answer ALL Questions Either (a) or (b)

16. (a) Explain the structure and composition of the Earth. **(K2)**

(OR)

(b) Describe the major types of plate boundaries and associated geological features. **(K2)**

17. (a) Analyze the applications of paleomagnetism in plate tectonic studies. **(K4)**

(OR)

(b) Analyze the concepts of isostasy, orogeny and epeirogeny. **(K4)**

18. (a) Discuss the relationship between geomorphology, climate and tectonics. **(K3)**

(OR)

(b) Explain seismic belts and seismicity at plate boundaries. **(K3)**

19. (a) Evaluate the role of weathering and pedogenesis in landscape development. **(K5)**

(OR)

(b) Evaluate the significance of mass movement, erosion and deposition in geomorphic evolution. **(K5)**

20. (a) Construct a detailed account of fluvial and glacial landforms. **(K6)**

(OR)

(b) Develop a comprehensive explanation of Aeolian, coastal and karst landforms. **(K6)**

PART – C (5 × 8 = 40)

Answer ALL Questions Either (a) or (b)

21. (a) Analyze the internal structure of the Earth and discuss the significance of lithosphere and asthenosphere in plate tectonics. **(K4)**

(OR)

(b) Analyze the role of plate tectonics in the formation of oceanic trenches, volcanic arcs and transform faults. **(K4)**

22. (a) Evaluate the importance of paleomagnetism in reconstructing continental positions and plate movements. **(K5)**

(OR)

(b) Evaluate the concepts of isostasy and mountain-building processes in crustal evolution. **(K5)**

23. (a) Analyze the influence of climate, structure and tectonics on landform development. **(K4)**

(OR)

(b) Analyze earthquake distribution, seismic belts and landscape alterations caused by seismic activity. **(K4)**

24. (a) Evaluate the geomorphic processes of weathering, pedogenesis and mass movement in shaping the Earth’s surface. **(K5)**

(OR)

(b) Evaluate the processes of erosion, transportation and deposition in geomorphic evolution. **(K5)**

25. (a) Construct a comprehensive account of Quaternary fluvial and coastal landscapes. **(K6)**

(OR)

(b) Develop a detailed explanation of Quaternary Aeolian landscapes and their geomorphic significance. **(K6)**

11. COURSE OUTCOMES (COs)

Four Course Outcomes (COs) for each course that can be achieved by the learners on completion of that particular course are as follows:

Considering outcomes related to

i. K1 and K2 level of evaluation in all the Units as CO1

ii. K3 level of evaluation in all the Units as CO2

iii. K4 level of evaluation in all the Units as CO3

iv. K5 and K6 level of evaluation in all the Units as CO4.

All the COs proposed in each of the courses should be mapped with POs based on the relevance.

Level of Correlation between COs and POs

0 – No Correlation 1 – Low 2 – Medium 3 – High

12. Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application-oriented content wherever required.
- The core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The curriculum is designed so as to strengthen the industry-Academia interface and provide more job opportunities for the students.

- The statistical quality control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship/Industrial training/Geological field visit during the end of second semester will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.

CREDIT DISTRIBUTION FOR M.Sc., GEOLOGY COURSE

2026-2027

	SUBJECT	C/E/SEC	Credits	Hours	Marks		
					CIA	EXT	Total
SEMESTER I							
1	Physical Geology and Geomorphology	C	5	7	25	75	100
2	Mineralogy and Instrumentation Techniques	C	5	7	25	75	100
3	**Practical:** Mineralogy and Instrumentation Techniques & Paleontology	C	4	6	50	50	100
4	Stratigraphy of India and its Application (Mandatory)	E	3	5	25	75	100
5	Recent Trends in Paleontology/ Urban Geology (Optional)	E	3	5	25	75	100
	Total		**20**	**30**			
SEMESTER II							
1	Structural Geology and Geotectonics	C	5	5	25	75	100
2	Igneous and Metamorphic Petrology	C	5	5	25	75	100
3	**Practical:** Structural Geology and Geotectonics and Petrology	C	4	8	50	50	100
4	Sedimentary Petrology (Mandatory)	E	3	4	25	75	100
5	Environmental Earth Science/ Isotope Geology (Optional)	E	3	4	25	75	100
6	Oceanography and Climatology	SEC	2	4	25	75	100
	Total		**22**	**30**			
SEMESTER III							
1	Economic Geology	C	5	6	25	75	100
2	Geophysics	C	5	5	25	75	100

3	Hydrogeology	C	5	5	25	75	100
4	**Practical:** Economic geology, Geophysics and Hydrogeology	C	4	6	50	50	100
5	Advanced Remote sensing and GIS / Medical Geology	E	3	4	25	75	100
6	Research Methodology	SEC	2	4	25	75	100
7	Internship/Industrial visit/Field visit		2	-	50	50	100
	Total		**26**	**30**			
SEMESTER IV							
1	Engineering and Mining Geology	C	5	6	25	75	100
2	**Practical:** Engineering and Mining Geology	C	5	6	50	50	100
3	Geochemistry/ Disaster Management	E	3	5	25	75	100
4	Coal and Petroleum Geology	SEC	2	5	50	50	100
5	Project with Viva Voce	C	5	8	50	50	100
6	**Extension activity** – Geological Field Mapping and long Field Visit -Report submission and viva voce.		3	-	50	50	100
	Total		**23**	**30**			
Grand Total			**91**				

C-core **E**-Elective **SEC**-Skill enhancement course

MANDATORY REQUIREMENTS FOR M.Sc. GEOLOGY PROGRAMME

1. **Geological Mapping** will be conducted in an area determined by the Professor-in-charge for the duration of 10 days for I M.Sc. Geology students together. Each student has to submit his/her Geological Mapping report separately during II M.Sc. final practical exams and there will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

2. **Short field trip**: Students have to complete at least two short field trips as determined by the Professor in- charge during First and Second year. A report on the short field trip is to be submitted by the individuals at the end of Third semester practical examinations. There will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

3. **Industries or In-plant Training**: Students have to undergo industrial training in any of the industries or implant/professional training in any of the industries, mining or institutes related to geosciences during first year summer holidays or third semester, in the form of groups/ individual. A report on the industrial training is to be submitted at the end of the third semester during the Practical examination. There will be a VIVA VOCE on it. Internal 50 marks and External 50 marks evaluated by external examiner.

4. **Geological Long Field Trip**: II M.Sc., Geology students have to undertake long field trip of duration of about three weeks to places of geological interest as determined by the Professor-in-charge. Submission of separate field report along with the specimens collected at the end of Second Year during the Practical examination is mandatory. There will be VIVA VOCE during Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

5. **Dissertation**: Students have to carry out a research project. The problem, area and topic will be determined by the Professor-in-charge during the course of study. Each student shall submit a dissertation at the end of second year course during the practical examination. There will be a VIVA VOCE during dissertation Practical Exam. Internal 50 marks and External 50 marks evaluated by external examiner.

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Physical Geology and Geomorphology	Core	Y	-	-	-	5	7	25	75	100

Course Objectives	
CO1	To understand the structure, composition, and tectonic framework of the Earth.
CO2	To study geomorphological concepts and the influence of climate, tectonics, and rock types on landforms.
CO3	To analyze geomorphic processes such as weathering, erosion, transportation, and deposition.
CO4	To identify and interpret major geomorphic landforms and their evolution.
CO5	To evaluate Quaternary landscapes and their geomorphological significance.

Unit	**Details**	**No. of Hours**	**Course Objectives**
I	Earth and its internal structure, composition, size and shape. An overview of plate tectonics including elementary concepts of plates, lithosphere, asthenosphere, types of plate boundaries and associated important geological features like oceanic trenches, volcanic arcs, accretionary wedges, topography of mid-ocean ridges and transform faults. Paleo-magnetism and its application for determining paleoposition of continents. Isostasy, Orogeny and Epeirogeny.	21	CO1
II	Concepts of geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Earthquakes and related landscape alterations, Seismic belts of the earth. Seismicity at plate boundaries. Principles of Geodesy.	21	CO2
III	Geomorphic Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition.	21	CO3
IV	Geomorphic landforms – fluvial, glacial, Aeolian, coastal, volcanoes and karst.	21	CO4
V	Quaternary landscapes. Fluvial landscapes, Aeolian landscapes, coastal landscapes.	21	CO5
	Total	**105**	

Text Books	
1.	Holmes, D.L. (1981) Principles of Physical Geology. ELBS Edition.
2.	Pethick, J. (1984) An Introduction to Coastal Geomorphology. Arnold, London.
3	Thornbury, W.D. (1969) Principles of Geomorphology. Wiley Eastern Ltd.
4	Richar Huggett, Fundamentals of Geomorphology
5	Strahler, A.N. (1952) Physical Geology. John Wiley & Sons Inc., New York.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Holmes, D.L. (1981) Principles of Physical Geology.ELBS Edition.

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

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Physical Geology and Geomorphology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the structure of the Earth, plate tectonics, paleomagnetism, and isostatic processes
CO2	Interpret geomorphological concepts and the influence of tectonics, climate, and rock types on landforms
CO3	Analyze geomorphic processes such as weathering, erosion, transportation, and deposition
CO4	Evaluate geomorphic and Quaternary landscapes including fluvial, glacial, aeolian, coastal, volcanic, and karst systems

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation: 0 - No correlation 1 - Low 2 - Medium 3 - High

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Mineralogy and Instrumentation Techniques	Core	Y	-	-	-	5	7	25	75	100

Course Objectives	
CO1	To understand crystal systems, symmetry elements, and principles of crystallography.
CO2	To study stereographic projections, zonal relations, and crystallographic calculations.
CO3	To identify and describe important mineral groups and their compositions.
CO4	To understand optical properties of minerals and principles of optical mineralogy.
CO5	To develop knowledge of analytical and spectroscopic techniques used in mineralogical studies.

Unit	Details	No. of Hours	Course Objectives
I	Introduction to crystallography – Crystal systems – Symmetry elements – Isometric, Tetragonal, Orthorhombic, Hexagonal, Monoclinic and Triclinic systems – Normal classes.	21	CO1
II	Stereographic projections – Axial ratio – Zones and zonal symbols – Tautozonal faces – Equation of the normal – Napier's Theorem – Tangent relations – Sine ratio – Cosine ratio.	21	CO2
III	Description and composition of the following mineral groups: Quartz, Feldspars, Feldspathoids, Micas, Garnets, Olivine, Pyroxenes, Amphiboles, Zeolites and Carbonate minerals.	21	CO3
IV	Introduction to Optical Mineralogy Electrical, magnetic and optical properties of minerals – Properties of light – Transmissivity and Reflectivity – Polarization – Extinction – Dichroism – Pleochroism – Interference colors – Refringence and Birefringence – Order of interference – Conoscopy – Interference figures - Concepts of crystal field theory and mineralogical spectroscopy.	21	CO4
V	Spot tests – Paper chromatography – Nephelometry – Turbidimetry – Spectroscopy – Flame photometry – X-ray spectroscopy – UV spectroscopy – Mass spectroscopy – Accelerated mass spectroscopy.	21	CO5
	Total	**105**	

Text Books	
1.	Donald Bloss F. (1971) Crystallography and Crystal Chemistry – An Introduction published by Holt, Rinehart and Winston, Inc., New York.
2.	William M. Blackburn and William H. Dennen (1988) Principles of Mineralogy (Second Edition) published by WCB Publishers England.
3.	Kerr P.F, Optical Mineralogy, 4th ed McGraw Hill New York (1977)
4.	Gribble C.D. &A.J. Hall, A. Practical Introduction to Optical Mineralogy,Springer.London(1985)
5.	*Tisljar, S.K. Haldar, Josip (2013). Introduction to mineralogy and petrology. Burlington: Elsevier Science.* ISBN 9780124167100.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Cornelis Klein and Cornelius S. Hurlbut, Jr. (1993) Manual of Mineralogy published by John Wiley & Sons, Inc. Singapore.
2.	Paul F. Kerr (1967) Optical Mineralogy, John Wiley & Sons, New York.
3.	*Wenk, Hans-Rudolf; Bulakh, Andrey (2016). Minerals: Their Constitution and Origin. Cambridge University Press.* ISBN 9781316425282.
4.	*Whewell, William (2010). "Book XV. History of Mineralogy". History of the Inductive Sciences: From the Earliest to the Present Times. Cambridge University Press. pp. 187–252.* ISBN 9781108019262.
5.	*Laudan, Rachel (1993). From mineralogy to geology: the foundations of a science, 1650-1830 (Pbk. ed.). Chicago: University of Chicago Press.* ISBN 9780226469478.

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Mineralogy and Instrumentation Techniques	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain crystal systems, symmetry elements, and crystallographic principles
CO2	Apply stereographic projection techniques and solve crystallographic problems
CO3	Identify and describe important mineral groups and their physical properties
CO4	Analyze optical properties of minerals and apply analytical techniques in mineralogical studies

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Mineralogy and Instrumentation Techniques & Paleontology Practical	Core	Y	-	-	-	5	6	50	50	100

Course Objectives			
CO1	To understand and identify crystal models and symmetry elements of different crystal systems.		
CO2	To apply stereographic projection techniques and crystallographic calculations.		
CO3	To identify minerals megascopically and microscopically based on physical and optical properties.		
CO4	To study the morphology, classification, and distribution of important fossil groups.		
CO5	To identify and interpret the morphological features of important microfossils.		
Unit	**Details**	**No. of Hours**	**Course Objectives**
I	Identification of crystal models of the following systems Normal class: Isometric, Tetragonal, Orthorhombic, Hexagonal, Monoclinic and Triclinic systems.	18	CO1
II	Stereographic projections – Axial ratio – Zones and zonal symbols – Tautozonal faces – Equation of the normal – Napier's Theorem – Tangent relations – Sine ratio – Cosine ratio.	18	CO2
III	Megascopic and Microscopic identification of the following group of minerals: Quartz, Feldspars, Feldspathoids, Micas, Garnets, Olivine, Pyroxenes, Amphiboles, Zeolites and Carbonate minerals.	18	CO3
IV	Study of the morphological characters and distribution of Porifera, Bryozoa, Mollusca, Brachiopoda, Trilobita, Echinoides, Coelenterata , Graptoloidea, corals and plant fossils.	18	CO4
V	Study and identifying the morphological features of micro-fossils: Foraminifera (Benthic and planktonic) Ostracoda and pteropods.	18	CO5
	Total	**90**	

Text Books	
1.	Donald Bloss F. (1971) Crystallography and Crystal Chemistry – An Introduction published by Holt, Rinehart and Winston, Inc., New York.
2.	William M. Blackburn and William H. Dennen (1988) Principles of Mineralogy (Second Edition) published by WCB Publishers England.
3.	Kerr P.F, Optical Mineralogy, 4th ed McGraw Hill New York (1977)
4.	Palaeontology Evolution and animal distribution. C. Jain and M.S. Anantharaman, (1996), Vishal Publications, Jalandhar.

5.	Invertebrate Palaeontology - H.Woods, (1985), CBS Publishers and Distributors, 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.	WILLIAM D. NESSE (2017) Introduction to Mineralogy, Third edition, Oxford University Press, New York.
3.	*Wenk, Hans-Rudolf; Bulakh, Andrey (2016). Minerals: Their Constitution and Origin. Cambridge University Press.*
4.	*Whewell, William (2010). "Book XV. History of Mineralogy". History of the Inductive Sciences: From the Earliest to the Present Times. Cambridge University Press. pp. 187–252.*
5.	*Amal Dasgupta (2012) An Introduction to Palaeontology. The World Press Pvt.Ltd, Kolkata.*

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Mineralogy and Instrumentation Techniques & Paleontology Practical	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Identify crystal systems and interpret crystallographic parameters using stereographic methods
CO2	Identify important minerals using megascopic and microscopic characteristics
CO3	Describe and classify major fossil groups based on morphological features
CO4	Identify and interpret microfossils and their geological significance

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Stratigraphy of India and its Applications (Elective-Mandatory)	Elective	Y	-	-	-	3	5	25	75	100

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

Unit	Details	No. of Hours	Course Objectives
I	Stratigraphy of India –Dharwar Supergroup – Mineral riches of Archaean. Cuddapah system and its mineral riches. Vidhyan system and its mineral riches. Cambrian System – Salt Range and Age of Saline Series. Ordovician and Silurian systems.	15	CO1
II	Stratigraphy of India (Contd.) - Devonian system. Carboniferous system. The Gondwana Group – Structure of the Gondwana Basin – Climate and Sedimentation – Economic minerals in the Gondwanas. Upper Carboniferous and Permian systems – Triassic system – Lilang system - Jurassic system – Jurassic of Kutch - Cretaceous system – Cretaceous of Trichinopoly.	15	CO2
III	Stratigraphy of India (Contd.) - Deccan traps – Lameta beds – Infra-trappean and Inter-trappean beds – Age of Deccan traps – Economic riches of Deccan traps. Tertiary group – Rise of the Himalayas – Eocene system and its Economic minerals – Oligocene and Lower Miocene systems and Petroleum – Middle Miocene and Lower Pleistocene – Siwalik system – Pleistocene and Recent – Human evolution and Culture – Glaciation and Human Culture – Chronology of Glaciation – Karewa formation Indo-Gangetic alluvium – Coastal deposits – Aeolian and other deposits– Useful Mineral deposits of Pleistocene and Recent.	15	CO3
IV	Applications of Stratigraphy – Geological time - Geologic time Units – Geochronology. Chronostratigraphy - Golden spikes – Global Standard Section and Point (GSSP) – Stratigraphic Units. Lithostratigraphy - Stratigraphic relationships - Lithostratigraphic Units – Lithodemic units – Application of Lithostratigraphy – Gaps in the record. Biostratigraphy – Fossils and Biostratigraphic correlation	15	CO4

	– Biostratigraphy in relation to other stratigraphic techniques.		
V	Applications of Stratigraphy (Contd.) Dating and correlation techniques – Radiometric dating – Application of radiometric dating – Other isotopic and chemical techniques – Chemostratigraphy – Magnetostratigraphy – Dating in the quaternary. Sequence stratigrphy - Sea-level changes – Sea level changes and sedimentation – Applications of sequence stratigraphy.	15	CO5
	Total	**75**	
	Text Books		
1.	Geology of India and BurmaM.S. Krishnan, (2010), 6th Edi., C.B.S publishers and Distributors, Delhi		
2.	Geology of India, D.N. Wadia, (1966), McMillan company, London		
3.	Vaidyanadhan.R&M.Ramakrishnan, Geology of India. Geological Society of India. Bangalore(2008)		
4.	MehdirattaR.C,Geology of India, Pakisthan, Bangladesh and Burma. Atma Ram &Sons.Delhi(1974)		
5.	Geology& Mineral Resources of the States of India. Misc Pub.No.30.Geological Survey of India. Kolkota. (Several individual volumes available online at GSI portal) GSI(2005).		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Fundamentals of Historical Geology and Stratigraphy of India, Ravindrakumar (1985), Wiley Eastern ltd, New Delhi.		
2.	Principle of Stratigraphy, Dunbar and Roggers, (1964), John Wiley and co, New York		
3.	An Introduction in Stratigraphy, Stamp L.D, (1964), Thomas Murby, Museum St, WCI, London.		
4.	Stratigraphic Principles and Practices, Weller, J.M, (1962), Harper & Bros, New York		
5.	Kumar R,Fundamentals of Historical Geology and Stratigraphy of India,WiIey.New Delhi (1988).		

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Stratigraphy of India and its Applications	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the stratigraphy, lithology, and economic importance of major Indian stratigraphic systems
CO2	Interpret geological history, palaeoenvironment, and tectonic evolution of Indian sedimentary basins
CO3	Apply concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, and geochronology
CO4	Evaluate dating, correlation, and sequence stratigraphic techniques in geological investigations

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Recent Trends in Paleontology (Elective-II Optional)	Elective	Y	-	-	-	3	5	25	75	100

Course Objectives	
CO1	To understand fossil records, geological time scale, and the origin and evolution of life.
CO2	To study the functional morphology and evolutionary significance of plants, vertebrates, and extinct organisms.
CO3	To analyze the morphology, classification, and evolution of major invertebrate fossil groups.
CO4	To understand micropalaeontological techniques, classification, ecology, and stratigraphic significance of microfossils.
CO5	To study the morphology and significance of Porifera, Bryozoa, stromatolites, spores, pollens, and other microfossils.

Unit	Details	No. of Hours	Course Objectives
I	Fossil record and geological time-scale. Origin and evolution of life – Phylogenetic and Ontogenic Analysis – Species Concept – Types of Fossils and Types of Species – Palingensis – Coenogensis – Proterogenesis - Thanatocoenosis – Biocoenosis – Sidocoenosis - Biomineralisation and Trace Fossils – Fossils and their uses – Biometrics – Major events in the history of Precambrian and Phanerozoic life.	15	CO1
II	Functional morphology, evolution and significance of Plant Fossils, Fishes, Horse, Elephant and Man. Dinosaurs and their extinction. Archaeopteryx. Gondwana and Tertiary Flora of India.	15	CO2
III	Functional morphology and evolution of Brachiopoda, Trilobita, Graptolites, Pelecypoda, Gastropoda, Cephalopoda, Coelenterata and Echinodermata.	15	CO3
IV	Micropalaeontological techniques –Sampling and collections, Separation from Unconsolidated and Consolidated sedimentary rocks. Foraminifera-Morphology, Classification, Geological history and Ecology/ Paleoecology. Ostracod-Morphology, Classification, Geological History and Ecology/Palaeo-ecology. Stratigraphy of microfossil- Precambrian, Paleozoic, Mesozoic and Cenozoic. Environmental Significance of Microfossil.	15	CO4

V	Porifera, Bryozoa-Morphology, Classification, Geological history and Ecology/Palaeo-Ecology. Brief introduction of morphology of Stromatolites, Conodonts, Pteropods, Radiolaria, Coccolith (Nano fossil). Maceration techniques. Spores and Pollens- Morphology and their significance.	15	CO5
	Total	**75**	
	Text Books		
1.	Palaeontology Evolution and animal distribution. C. Jain and M.S. Anantharaman, (1996), Vishal Publications, Jalandhar.		
2.	Invertebrate Palaeontology - H.Woods, (1985), CBS Publishers and Distributors, New Delhi.		
3.	Agashe, S.N, Paleo botany, Oxford & IBH. Delhi(1995)		
4.	Stewart W.N. & G.W. Rothwell, Palaeobotany, Cambridge University Press. D 2005)		
5.	Moore R.C. et al., Invertebrate Fossils. CBS. Delhi (1952).		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Principles of Invertebrate Palaeontology, Shrock R.R and Twenohofel W.H, (2005), CBS Publishers and Distributors, New Delhi.		
2.	Invertebrate Fossils. Moore R.C, Lalicker C.G and Fisher A.G (1952) McGraw Hill.		
3.	The Vertebrate Story, Romer A.S, (1959) University of Chicago Press, 4thEdt. Chicago.		
4.	Palaeontology An Introduction, E.W.Nield and V.C.T.Tucker (1985) Pergamon Press, Oxford.		
5.	Colbert E.H. et al.,Evolution of the Vertebrates, Wiley. New Delhi 2002)		

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Recent Trends in Paleontology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain fossil records, geological time scale, and evolutionary history of life
CO2	Analyze the morphology and evolution of vertebrate and plant fossils
CO3	Interpret the classification, morphology, and evolution of major invertebrate fossil groups
CO4	Apply micropalaeontological techniques and evaluate the ecological and stratigraphic significance of microfossils

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

SEMESTER – 1

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Urban Geology (Elective-II Optional))	Elective	Y	-	-	-	3	5	25	75	100
Course Objectives											
CO1	The objectives this course is to enhance the knowledge to protect the environment										
CO2	To improve public health and safety,										
CO3	To increase the wealth of choices.										
CO4	To Analyze responsive technology for long-term changes in urban coastal and river										
CO5	To understand the concepts of GIS in Urban Geology										
Unit	**Details**							**No. of Hours**		**Course Objectives**	
I	Geology and Society, Necessity of Geology in Urban life. Geology in Urban Constructions, Geotechnical feature and mapping for subsurface in Metropolitan areas, Building materials, Excavation and cutting in urban areas.							15		CO1	
II	Geology and Urban Agriculture, Soil studies, Chemistry and geochemistry of soil in relation to groundwater and fertilizer Effect of pollutants on agricultural land.							15		CO2	
III	Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban landuse, Geological problems in construction of underground structures in urban areas. Urban Tunnelling: Tunnelling for road and rail in urban areas, Method, Equipments, Important Geological parameters.							15		CO3	
IV	Urban water: Water lagging in built-up areas, Source of water, Standards for various uses of water. Sources of contamination, Ground water surveys and resource development. Urban wastes and Treatment, Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Minedrainage, Power production waste, Radio active waste, mapping for selection of waste disposal site							15		CO4	
V	GIS in Urban Geology: GIS-An introduction, Application in Urban development, Application in landuse, Application in groundwater. Precaution from seismic hazard in Urban planning Micro-zonation mapping for hazard.							15		CO5	
	Total							**75**			

	Text Books
1.	P. Willems, J. Olsson, K. Arnbjerg-Nielsen, S. Beecham, A. Pathirana, I. B. Gregersen, H. Madsen, V.-T.-V. Nguyen (2012) Impacts of Climate Change on Rainfall Extremes and Urban Drainage Systems.IWA Publishing, UK.
2.	M.G.Mansell (2003) Rural and urban hydrology, ICE Publishing.
3.	Martin van Maarseveen, Javier Martinez and Johannes Flacke (2019) GIS in Sustainable Urban Planning and Management : A Global Perspective. CRC Press.
4.	John Randolp (2003) Environmental Land Use Planning and Management.,Island Press.
5.	Timothy L. Nyerges, PiotrJankowski, StanGeertman, Helen Couclelis and Jacek Malczewski (2010) Regional and Urban GIS: A Decision Support Approach. CRCPress
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Daniel T. Rogers, (2020) Urban Watersheds Geology Contamination Environmental Regulations And Sustainability. Taylor and Francis.
2.	Mary J. Thornbush and Casey D. Allen (2018) Urban Geomorphology: Landforms and Processes in Cities. Elsevier Science.
3.	Lollino,G. et al.(2015), Engineering Geology for Society and Territory. Springer.

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Urban Geology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the significance of geology in urban development, construction, and land-use planning
CO2	Analyze soil characteristics, urban agriculture, and the impact of pollutants on the environment
CO3	Evaluate geotechnical site conditions, tunnelling methods, and urban water and waste management systems
CO4	Apply GIS techniques and hazard assessment methods in urban planning and disaster mitigation

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

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

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

Unit	Details	No. of Hours	Course Objectives
I	Theory of stress and strain – Behavior of rocks under stress – Mohr's circle – Various states of stress and their representation by Mohr's circles – Different types of failure and sliding criteria – Geometry and mechanics of fracturing and conditions for re-activation of pre-existing discontinuities – Paleostress analysis – Common types of finite strain – Ellipsoids – L, L-S-, and S-tectonic fabrics.	15	CO1
II	Techniques of strain analysis – Particle paths and flow patterns. Deformation mechanisms – Role of fluids in deformation processes – Geometry and analysis of Brittle and ductile shear zones; their geometry, strain pattern, kinematics and significance. Rotation of structural elements. Petro-fabric analysis – Field and laboratory techniques – tectonics and their symmetry – Application of stereographic projection in the solving of structural problem, Point and percentage diagrams.	15	CO2
III	Rotated minerals – Syn-, pre- and post-kinematic – Differential movement in rocks using rotated minerals – Oscillatory movements – Characteristics – Neotectonics – Indian evidences – Methods of study of neotectonics. Sheath folds – Geometry and mechanics of development of Boudins, Foliation- Concept and classification of foliation, Usefulness of foliation in structural analysis. Lineation- Concept and classification of lineation, Usefulness of lineation in structural analysis.	15	CO3
IV	Geometry and mechanics of folding, minor fold-origin and relation to major structure. Classification and types of folds and mechanics of similar folding. Recognitions of folds in the field. Study of joints - their classification and	15	CO4

	significances, Faults – Classification – types- Normal, thrust and slip faults. Mechanics of faulting with reference to stress and stress ellipsoids. Recognition of faults in the field. Unconformities- their classification and significances.		
V	Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains – Geological and geophysical characteristics of plate boundaries – Geodynamic evolution of the Himalayas – Palaeomagnetism – Sea floor spreading and plate tectonics – Island arcs, oceanic islands and volcanic arcs – Isostasy, orogeny and epeirogeny – Geodynamic of the Indian Plate.	15	CO5
	Total	**75**	
	Text Books (Latest Editions)		
1.	Billings, M.P. (2014) Structural Geology. Prentice-Hall, Inc., Learning Pvt. Ltd., Delhi. 3rd Edition. ISBN: 978-81-203-0059-03.		
2.	Chiplonkar C.W. & Power K.B., (1988), Geological Maps, Dastane Ramchandra& Co., Pune.		
3	Haakon Fossen, 2010. Structural Geology, Cambridge University Press.		
4	Twiss, R.J. and Moores, E.M. (2007).Structural Geology. W.H.Freeman and Company, New York. 2nd Edition. ISBN: 10: 0-7167-4951-		
5	Radhakrishna, T and Piper, J. D. A., (ed.), The Indian Subcontinent and Gondwana: A Palaeomagnetic and Rock Magnetic Perspective, JGSI Memoir 44.		
6	Davis, G.H., Reynolds, S.J., 1996, Structural geology of rocks and regions, 2nd Edition, John Wiley & sons.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Suppe, J. (1985) Principles of Structural Geology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: ISBN 0137105002.		
2.	Marshak, S. and Mitra, G. (1988) Basic Methods of Structural Geology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. ISBN: 0130651788.		
3.	*M. King Hubbert (1972). Structural Geology. Hafner Publishing Company.*		
4.	*G.H. Davis and S.J. Reynolds (1996). The structural geology of rocks and regions (2nd ed.).* Wiley. ISBN 0-471-52621-5.		
5.	*C.W. Passchier and R.A.J. Trouw (1998). Microtectonics. Berlin:* Springer. ISBN 3-540-58713-6.		

1. PSO Mapping

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total
Structural Geology and Geotectonics	3	3	3	2	2	2	1	16

2. Course Outcomes

CO	Course Outcome
CO1	Explain stress, strain and deformation behavior of rocks using Mohr's circle
CO2	Analyze strain, deformation mechanisms, shear zones and petro-fabric methods
CO3	Interpret folds, foliations, lineations and neotectonic evidences
CO4	Evaluate faults, joints, unconformities and geodynamics

3. CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	2	2	1	1	-
CO4	3	3	2	2	2	2	1

4. CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	2	2	1	1	-
CO4	3	3	2	2	2	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Igneous and Metamorphic Petrology	Core	Y	-	-	-	5	5	25	75	100

Course Objectives	
CO1	To understand the forms, textures, structures, and classification of igneous rocks and magma dynamics.
CO2	To study phase equilibria, Bowen's reaction principle, and phase relations in silicate systems.
CO3	To analyze the petrogenesis of important igneous rock suites of India.
CO4	To understand the principles, agents, types, and effects of metamorphism and metamorphic rocks.
CO5	To study metamorphic facies, phase diagrams, metasomatism, and metamorphism in relation to tectonics and orogenesis.

Unit	Details	No. of Hours	Course Objectives
I	Forms, textures and structures of igneous rocks. Magma Dynamics: Physical properties of magmas (viscosity, density, temperature); heat transport in magmatic systems. Classification of Igneous Rocks: classification based on mineralogy: color index, IUGS classification. Classification based on chemical composition: Total Alkali Silica, Alkali Lime Index.	15	CO1
II	Steady-state geotherms, Bowen's reaction principle, The Phase Rule: Application of the Gibbs Phase Rule to silicate systems. Binary Systems: In-depth study of Eutectic (Ab-An), Peritectic (Fo-Silica), and Solid Solution (Ab-An) systems. Ternary Systems**:** Phase relations in Di-Ab-An, Di-Fo-An, and Di-Fo-Silica system.	15	CO2
III	Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, charnockites, alkaline rocks (Syenites, Nepheline Syenites, Carbonatites) Kimberlites, ophiolites and granitoids.	15	CO3
IV	Concept of Metamorphism: The limits of metamorphism – Metamorphic agents and changes – Temperature, Pressure, stress, and Metamorphic fluids. Different Types of metamorphism. Thermal, cataclastic and regional metamorphism and their effects on carbonates, argillaceous, arenaceous and acid, basic and ultrabasic igneous rocks. Retrograde metamorphism. Mineralogical Phase rule: Gibbs and Goldschmidt's rule. Classification	15	CO4

	of metamorphic rocks. Metamorphic textures and structures. Metamorphic grades and zones.		
V	Concept of metamorphic facies: facies classification of metamorphic rocks. Views of Eskola, Winkler, Turner and Verhoogen. Phase relations: ACF, AFM and AKF phase diagrams for metamorphic mineral assemblages. Gibbs Phase Rule and Mineralogical Phase rule of closed and open systems. Metamorphic differentiation. Metasomatism, Granitisation. Migmatisation, Charnockitisation, Palingenesis, Origin of Eclogites, origin of Amphibolites metamorphism in relation to plate tectonics, Magmatic emplacements and orogenesis.	15	CO5
	Total	**75**	

	Text Books
1.	**Philpotts, A. R., & Ague, J. J.** – Principles of Igneous and Metamorphic Petrology. (The "Gold Standard" for thermodynamics and phase diagrams).
2.	**Winter, J. D.** – Principles of Igneous and Metamorphic Petrology. (Excellent for student-friendly explanations of complex concepts).
3.	**Frost, B. R., & Frost, C. D.** – Essentials of Igneous and Metamorphic Petrology. (Concise and highly effective for competitive exam revision).
4.	**Best, M. G.** – Igneous and Metamorphic Petrology. (Detailed descriptive petrography).
5.	**Subbarao, K. V.** – Deccan Flood Basalts. (Specific insights into Indian LIPs).
6.	**Mahadevan, T. M.** – Geology of Bihar and Jharkhand (or general papers on the Eastern Ghats/Dharwar Craton for Indian alkaline/granitoid suites).
7.	**Wilson, M.** – Igneous Petrogenesis: A Global Tectonic Approach. (Best for understanding magmatism in relation to plate tectonics).
8.	**McBirney, A. R.** – Igneous Petrology. (Focused on the physical and chemical behavior of magmas).
9.	**G.W. Tyrrell** – The Principles of Petrology. (Classical foundation for petrographic textures).
10.	Miyashiro, A. (1973)., Metamorphism and metamorphic belts Allan and Unwin.
11.	John D Winter, (2010)., Principles of Igneous and Metamorphic Petrology- PHI publishers.
12.	Chatterjee, S.C (1974), Petrography of the Igneous and Metamorphic,
13.	BhaskarRao,(1986), Metamorphic petrology, International Book house, Delhi.

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.	Hatch, F.E, Wells, A.K and Wells, M.K, (1949) Petrology of igneous rocks, Thomas Mury andco.
3.	Winter,J.D,Principles of Igneous and Metamorphic Petrology, PHI.New
4.	Bowen,n.l.,(1968) -Evolution of igneous rocks dover publication.
5.	Sood, M.K. (1982) Modern Igneous Petrology, Wiley-Interscience Publ., New York.
6.	Bucher, K. and Frey, M., (1994)., Petrogenesis of Metamorphic Rocks-Springer Verlag
7.	Winkler, H.G.F., (1974), Petrogenesis of Metamorphic Rocks, 5th edn., Springer-Verlag.

8.	Yardley, B.w., (1989)., An Introduction to Metamorphic Petrology-Longman, New York.

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Igneous and Metamorphic Petrology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the classification, textures, structures, and magma dynamics of igneous rocks
CO2	Analyze phase equilibria, Bowen's reaction principle, and silicate phase systems
CO3	Evaluate the petrogenesis of important igneous rock suites of India
CO4	Interpret metamorphic processes, facies, phase relations, and tectonic significance of metamorphism

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester II

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Structural Geology and Geotectonics & Petrology Practical	Core	Y	-	-	-	4	8	50	50	100

Course Objectives	
CO1	Interpret and analyze geological maps involving various structures.
CO2	Apply stereographic projection techniques to plot and interpret structural data.
CO3	Perform quantitative structural calculations.
CO4	To identify different rock types by megascopic and microscopic characters.
CO5	To interpret rock composition and depositional environments.

Unit	Details	No. of Hours	Course Objectives
I	**Geological Map Interpretation & Mapping:** • Interpretation of geological maps with complex structural features (unconformities, folds, faults). • Drawing cross-sections across folded and faulted terrains, including inlier and outlier cases. • Completion of boundary lines and computing geological history from maps.	24	CO1
II	**Stereographic and Equal Area Projections:** • Plotting linear and planar data (strikes, dips, lineations) using stereonets and rose diagrams. • Calculation of fold axis (Beta-diagram), and determining orientations of faults and joints. • Solving problems related to borehole data.	24	CO2
III	**Quantitative Structural Analysis:** • **Thickness & Depth:** Calculations of true thickness, vertical thickness, and horizontal equivalent of beds. **Field Techniques:** • Measurement of structural elements in the field using Brunton compass.	24	CO3
IV	Megascopic and microscopic studies of important Igneous, Metamorphic and Sedimentary rocks.	24	CO4
V	Norms calculation, Harker's, Larsen's variation diagrams – Peacock's Alkali-Lime Index – Niggli's variation diagram – Grain size analysis – Statistical parameters in Sedimentology – Frequency and cumulative frequency distribution curves.	24	CO5
	Total	**120**	

	Text books
1.	Brian Simpson. (1968).Geological Maps. Pergamon Press Limited, Oxford.
2.	Lisle, R.J. (1988).Geological Structures and Maps. Pergamon Press, Oxford.
3	Gass, J.G., Butcher, N.E., Clark, P., Francis, P.W., Jackson, D.E., McCurry, P., Skipsey, E., Smith, P.J., Stevenson, J., Thorpe, R.S., Turner, C., Wilson, R.C.L., Wright, J.B. (1972). Field Relations – A Second Level Course in Science. The Open University Press, London.
4.	Structural geology, Billing. M.P. (1974), Prentice Hall, New Delhi
5.	An outline of Structural Geology, Hobbs, B.E., Means, W.D. and Williams, P.F. (1976), John Wiley, New York.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Bhattacharya, D.S. and Bagchi, T.C. (1973).Elements of Geological Map Reading and Interpretation with Exercises. Orient Longman Limited, Calcutta.
2.	Gokhale, N.W. (2006).A Manual of Problems in Structural Geology. CBS Publishers and Distributors, New Delhi.
3.	Basic Problems of GeotectonicsBelousov.V.V. (1962): McGraw Hill, New York
4.	Structural GeologyDe Sitter. L.U. (1956): McGraw Hill, New York
5.	Elements of Structural GeologyHill. E.S. (1972): John Wiley, New York

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Structural Geology and Geotectonics & Petrology Practical	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Interpret geological maps and construct cross-sections including structural complexities
CO2	Apply stereographic projections and analyze structural data using stereonets
CO3	Perform quantitative structural analysis and field measurements using geological tools
CO4	Evaluate rocks and apply geochemical and sedimentological analytical techniques

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	1	-	-
CO2	3	3	3	3	2	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	1	-	-
CO2	3	3	3	3	2	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

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

Course Objectives	
CO1	To understand sedimentary processes, depositional environments.
CO2	To study sediment texture, structures, and statistical parameters.
CO3	To classify and interpret sedimentary rocks and their diagenetic features.
CO4	To analyze sedimentary basins, tectonic settings, and basin evolution.
CO5	o develop knowledge on field and laboratory techniques

Unit	Details	No. of Hours	Course Objectives
I	Sedimentary processes: Rock cycle, weathering, transportation, deposition, digenesis and lithification. Mode and mechanism of sediment dispersal, classification, source and transporting agencies of sediments, Fluvial, lacustrine and eolian processes. Role of weathering and sedimentation in evolution of continental crust. Depositional environments-Facies: Terrestrial Fluvial, glacial, aeolian and lacustrine systems. Transitional- deltaic, beach and Barrier Island, estuarine and tidal flat systems.	12	CO1
II	The texture of sediments and sedimentary rocks: Concept of particle size and grade scale. Parameters of frequency distribution-mean, mode, sorting coefficient, skewness and kurtosis and their significance. Graphic parameters of Folk and Ward, application in palaeo-environment studies. Shape and roundness-Porosity and permeability-Mineral as provenance indicators. Structures of sedimentary rocks: Structures of mechanical, chemical and biogenic origin. Flow regime concept.	12	CO2
III	Origin of sedimentary rocks: mechanical, chemical and biological rocks. Classification of sedimentary rocks: Siliciclastic rocks-conglomerates, breccia, sandstones, mud rocks- their description, classification and diagenesis. Biogenic, chemical and other nonsiliclastic rocks – carbonate rocks- types, classification and their diagenesis. Siliceous, phosphatic and iron-rich and evaporite sediments and sedimentary rocks- varieties and environments of formation. Petrographic studies of common sedimentary rocks.	12	CO3
IV	Methods of heavy minerals separation and their significance in sedimentary Petrology sedimentary environments-physical and chemical factors in sedimentation. Types of sedimentary basins and their	12	CO4

	tectonic settings-divergent, intraplate, convergent, transform and hybrid settings- fore arc, back arc and retro arc basins. Sedimentary basins of India and its tectonic framework. Tectonics and sedimentation, Classification, definition and description of sedimentary basins, basin analysis. Sedimentary basins of India.		
V	Field and Laboratory techniques in Sedimentology; Sedimentary structures-Preparation of lithologs, rock and thin section staining, Cathodoluminescence, use of Counter, diagenesis and Fluid flow, Diagenesis of Mudstone, Sandstone and Carbonate rocks;. Clay Mineralogy, classification of clay- Sedimentary basins and their classification, basin analysis (maps, cross sections, Isopach, petrofacies, geological history, applications); Concept of sequence stratigraphy.	12	CO5
	Total	**60**	
	Text Books		
1.	Friedman, G.M and Sanders, J.L., 1978: Principles of Sedimentology, John Wiley.		
2.	Allen, J.R.L., 1985: Principles of Physical Sedimentation, George Allen & Unwin.		
3.	Pettijohn, F.J., Potter, P.E. and Siever, R., 1990: Sand and Sandstone. Springer Verlag.		
4.	Blatt, H, Murray, G.V. and Middleton, R.C., 1980: Origin of Sedimentary Rocks.		
5.	Bhattacharya, A and Chakraborti, C., 2000: Analyses of Sedimentary Successions. Oxford – IBH.		
6.	Sengupta, S., 1997: Introduction to Sedimentology, Oxford – IBH.		
7.	Boggs Sam Jr., 1995: Principles of Sedimentology and Stratigraphy, Prentice Hall.		
8.	Nichols, G., 1999: Sedimentology and Stratigraphy. Blackwell.		
9.	Davis, R.A. Jr., 1992: Depositional Systems. Prentice Hall.		
10	Reading, H.G. 1996: Sedimentary Environments. Blackwell.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Selley, R.C., 1976: An Introduction to Sedimentology, Academic Press, London.		
2.	Miall, A.D., 2000: Principles of Sedimentary Basin Analysis. Springer Verlag.		
3.	Einsele, G., 1992: Sedimentary Basins. Springer Verlag.		
4.	Reineck, H.E. and Singh, I.B., 1980: Depositional Sedimentary Environments. Springer -Verlag.		
5.	Prothero, D.R. and Schwab, F., 1996: Sedimentary Geology. Freeman.		

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Sedimentary Petrology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain sedimentary processes, depositional environments, and sediment dispersal mechanisms
CO2	Analyze sediment texture, structures, and statistical parameters for palaeo environmental interpretation
CO3	Classify sedimentary rocks and interpret their origin, diagenesis, and petrographic characteristics
CO4	Evaluate sedimentary basins, tectonic settings, and laboratory techniques used in sedimentological studies

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

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

Course Objectives	
CO1	To understand the concepts of environment, environmental monitoring, and water resources.
CO2	To study sources, effects, and control measures of air and water pollution.
CO3	To analyze smog formation, greenhouse gases, acid rain, and climate-related environmental issues.
CO4	To evaluate methods of waste management, disposal, and environmental sustainability.
CO5	To understand medical geology, environmental contaminants, and alternate energy resources.

Unit	Details	No. of Hours	Course Objectives
I	Concept of environment – Environmental monitoring – Water as a resource, Water pollution – Point and non-point pollution sources – Ground water pollution.	12	CO1
II	Air pollution – Natural and anthropogenic sources of air pollution – Primary and secondary air pollutants – Anthropogenic activities and air pollution – Indoor air quality – Biological sources of indoor pollution – Health effects – Air quality standards – Case histories – Air quality monitoring – Acid rain – Adverse effects of acid rain – Health effects – Mitigation measures – Roles and responsibilities.	12	CO2
III	Smog – Mechanism of smog formation – Health disorders – Photochemical smog – Ozone and PAN formation – Health effects – Catalytic converters – Greenhouse gases and effect – Processes of removal of greenhouse gases.	12	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
	Total	**60**	
	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, Introduction to International Disaster Management, Butterworth Heinemann (2007).
4.	Pine,J.C, Natural Hazards Analysis: Reducing the Impact of Disasters, CRC Press, Taylor and Francis Group(2009).
5.	Smith K, Environmental Hazards: Assessing Risk and Reducing Disaster Rout ledge Press (2001).
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Strahler, A.N. and Strahler, A.H. (1973) Environmental Geoscience – Interaction between Natural Systems and Man. Hamilton Publishing Co., Santa Barbara, California.
2.	Kudesia, V.P. (1980) Water Pollution. Pragathi Prakasam, Meerut.
3.	Groundwater Assessment Development and Management, Karanth.K.R. (1987) Tata McGraw Hill Publishing Company, Ltd.
4.	Miller T.G. Environmental Science. Wadsworth Publishing.US(2004).
5.	Coates, D.R. Environmental Geology. McGraw Hill. NewYork(1984)

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Environmental Earth Science	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain environmental concepts, monitoring methods, and issues related to water resources and pollution
CO2	Analyze sources, impacts, and control measures of air pollution, acid rain, and indoor pollution
CO3	Evaluate smog formation, greenhouse gas effects, waste management techniques, and environmental sustainability
CO4	Apply concepts of medical geology, environmental contamination, climate change, and alternate energy resources

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

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

Course Objectives	
CO1	To understand the principles, properties, and classification of isotopes in geology.
CO2	To study the distribution and geochemical behavior of radioactive isotopes and minerals.
CO3	To analyze instrumentation, radioactive dating methods, and applications of isotopes in geology and hydrology.
CO4	To understand stable isotopes in hydrological and atmospheric systems and their role in palaeoclimate reconstruction.
CO5	To study tracer techniques, groundwater dating, and isotope applications in hydrogeology and environmental studies.

Unit	Details	No. of Hours	Course Objectives
I	Introduction to Isotope Geology: Introduction Basic principles of Isotope Geology–Chemical properties of Isotopes, Thermo dynamic properties of Isotopic compounds Equilibrium constants, separation of isotopes-Physical and chemical methods-Classification of Isotopes-Relationship between radio nuclides and its decay products, Units of radio activity measurement.	12	CO1
II	Distribution and properties of Isotopes: Distribution of Radioactive elements in Igneous, Sedimentary and Metamorphic rocks and waters-Study of important unstable isotopes. Distribution of Radioactive mineral deposits in India - Geochemical behaviour of Uranium and Thorium – Natural production-Anthropogenic releases of radio nuclides.	12	CO2
III	Instrumentation and methods of application of radioactive isotopes: Measurement of radioactivity-Scintillation counters, Mass spectrometer. Isotopic dilution techniques. Geochronometry, Age of the earth, Age of the element, rate and age of deposition, radioactivity and genesis of petroleum. Use of radioactivity in Well logging. Application of environmental isotopes. Fractionation of stable isotopes in lithosphere, Hydrosphere and Atmosphere. Stable isotopes and their uses.	12	CO3
IV	Stable isotopes and its nature: Stable isotopes in water cycle - Relation between $^{18}O/^{16}O$ and $^{2}H/^{1}H$ Hinnatural waters–Evaporation, Clouds and Precipitation-marine and continental atmosphere. Isotope effects in precipitation -	12	CO4

	The latitude / annual temperature effect - Seasonal effect – Oceanic and continental precipitation - Altitude effect – Amount effect – Inter annual variations - Small-scale variations - Palaeoclimate reconstruction. Tritiumin the atmosphere - Characteristics of tritium -Geophysical aspects - Hydrological aspects. Atmospheric CO_2 - Atmospheric CO_2 concentrations –Stable carbon isotopes in atmospheric CO_2-Stable oxygen isotopes in atmospheric CO_2-Radiocarbon in atmospheric CO_2. Water Sampling and Treatment - Water sampling and storage -Laboratory treatment of water samples - $^{18}O/^{16}O$ analysis - $^{2}H/^{1}H$ analysis - ^{3}H analysis of water -^{14}C analysis of dissolved inorganic carbon -$^{13}C/^{12}C$ analysis of dissolved inorganic carbon.		
V	Micropaleontology: Sampling methods and sample Tracer techniques in hydrogeology: Tracers and transports- Types of tracers-Types of tracer experiments – Isotopic tracers. Water Rock Interaction - physical absorption -Chemical absorption -Exchange of ions - Chemical interaction between solutes. Low Temperature System - Unsaturatedzone-Geohydraulicaspects-Solutetransport–Applications-Saturatedzone-Origin of groundwater- Groundwater dating -The radiocarbon dating - ^{14}C standard - natural ^{14}C variations - ^{14}C age determination - Dating groundwater with DIC and DOC - Relation between ^{13}C and ^{14}C variations –Comparison of ^{3}H and ^{14}C variations. High Temperature Systems-Natural processes-Anthropogenic processes	12	CO5
	Total	**60**	
	Text Books		
1.	Henry Faul,(1954). NuclearGeology, JohnWiley & Sons, NewYork,		
2.	Kalvero Rankama, (1954). Progress in Isotope Geology, Pergamon press, London.		
3.	Gaunter Faure,(1986). Principles of Isotope Geology, JohnWiley & Sons, NewYork, 2nded.		
4.	Aswathnarayana, U.(1985). Principles of Nuclear Geology, Oxonian Press(P) Ltd., NewDelhi.		
5.	Rankama and Sahama,(1950).Geochemistry, University of Chicago Press,.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Albarede F.(2003) Geochemistry-An introduction, Cambridge University press		
2.	Mason, B. and Moore, C.B. (1985) Principles of geochemistry, Wiley Eastern Ltd, Bangalore		
3.	Faure, G., Mensing, T. M., Tsotopes (1990) – Principles and Applications, Wiley India Pvt. Ltd.,NewDelhi		

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Isotope Geology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the principles, properties, and classification of isotopes and radioactive elements
CO2	Analyze the distribution, geochemical behavior, and applications of isotopes in geological systems
CO3	Apply isotopic techniques, radiometric dating, and instrumentation in geological and hydrological studies
CO4	Evaluate stable isotopes, tracer methods, groundwater dating, and palaeoclimate reconstruction techniques

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High

Semester- II

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Oceanography and Climatology (Skill Enhancement Course)	SEC	Y	-	-	-	2	4	40	60	100

Course Objectives	
CO1	To understand the physical and chemical characteristics of oceans and atmosphere.
CO2	To study ocean circulation, marine processes, and atmospheric systems influencing climate and weather.
CO3	To analyze ocean floor morphology, tectonics, and ocean-atmosphere interactions.
CO4	To understand radiation balance, atmospheric thermodynamics, and physical meteorology.
CO5	To study cloud physics, atmospheric turbulence, and precipitation mechanisms.

Unit	**Details**	**No. of Hours**	**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	12	CO4

	radiation, radiation windows, radiative transfer, Greenhouse effect, net radiation budget; Clausius – Clapeyron equation.		
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
	Total	**60**	
	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; Johnson, Martin Wiggo*; Fleming, Richard H. (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 (Latest editions, and the style as given below must be strictly adhered to)			
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. Infinite-Dimensional Dynamical Systems in Atmospheric and Oceanic Science, 2014, World Scientific Publishing, ISBN 978-981-4590-37-2.		
4.	Hamblin, Jacob Darwin (2005) Oceanographers and the Cold War: Disciples of Marine Science. University of Washington Press. ISBN 978-0-295-98482-7		
5.	Roorda, Eric Paul, ed. The Ocean Reader: History, Culture, Politics (Duke University Press, 2020) 523 pp.		

1. PSO Mapping (Course vs PSOs)

Course Title	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	Total Score
Oceanography and Climatology	3	3	3	3	2	2	1	17

2. Course Outcomes (COs)

CO	Course Outcome Statement
CO1	Explain the physical and chemical properties of oceans, seawater, and atmospheric systems
CO2	Analyze ocean circulation, climatic systems, monsoons, and atmospheric processes
CO3	Evaluate ocean floor morphology, tectonic domains, and ocean-atmosphere interactions
CO4	Apply concepts of radiation balance, cloud physics, and atmospheric turbulence in meteorological studies

3. Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

4. Mapping of COs with PSOs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	-	-	-
CO2	3	3	3	2	1	-	-
CO3	3	3	3	3	2	1	-
CO4	3	3	2	3	3	2	1

Level of Correlation:

0 - No correlation 1 - Low 2 - Medium 3 - High