

Central University of Himachal Pradesh

Department of Geology

School of Earth and Environmental Sciences

AGENDA



**2nd BOARD OF STUDIES MEETING
TO BE HELD ON 4th APRIL, 2026**

Santosh . *Nansen Chandini*

Venue:- O/o the Dean Academics Office, Dhauladhar Campus, Dharamshala (HP)



फ़ाइल सं.: GEO/1-5/BoS/CUHP/25/
हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
(Accredited by NAAC with 'A+' Grade with CGPA of 3.42)
(भूविज्ञान विभाग)
(Department of Geology)



दिनांक: 04/04/2026

AGENDA-INDEX

Agenda Item No.	Particulars	Information
GEO-BOS-2/26-1	To discuss the course basket for the MSc and PhD Geology	Annexure –I
GEO-BOS-2/26-2	To discuss and approve the revised course structure and course contents of the M.Sc. Geology as per NEP 2020.	Annexure –II, III and V
GEO-BOS-2/26-3	To discuss and approve the revised course structure for one semester of coursework in the PhD in Geology	Annexure –IV
GEO-BOS-2/26-4	Any other matter with the Chairs approval	


Prof. Ambrish Kumar Mahajan
Head,
Department of Geology


Santosh

Narain Chandra

Central University of Himachal Pradesh

Department of Geology

under

School of Earth and Environmental Sciences

MINUTES



2nd BOS MEETING

HELD ON April 04th, 2026

 Nansen Chaudhary

Venue:

CENTRAL UNIVERSITY OF HIMACHAL PRADESH,
Dean Academics Office, Dhauladhar Campus, Dharamshala (HP)



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
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Shahpur, Distt. Kangra (HP) - 176206
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File No.

Dated: 04.04.2026

Department of Geology

Minutes of the 2nd Meeting of BoS

Minutes for the 2nd BoS meeting of the Department of Geology, School of Earth & Environmental Sciences, Central University of Himachal Pradesh, held on April 4th, 2026, at the Dean Academics Office, CUHP, Dhauladhar Campus, in hybrid mode are as under:

The following members were present:

1. Prof. A.K. Mahajan, Head, Department of Geology, School of Earth and Environmental Sciences, CUHP, Dharamshala- Chairman
2. Prof. Naveen Chaudhri, Department of Geology, Panjab University, Chandigarh- External Expert
3. Prof. Santosh Kumar, Department of Geology, Kumaon University, Nainital, Uttarakhand - external Expert (online: <https://meet.google.com/ixw-zfye-nev>)
4. Prof. Deepak Pant, Dean, School of Earth and Environmental Sciences, CUHP, Dharamshala
5. Prof. Rajesh Kumar, Department of Physics and Astronomical Sciences, CUHP, Dharamshala (online) -Vice Chancellor Nominee
6. Dr. Kumar Batuk Joshi, Department of Geology, School of Earth and Environmental Sciences, CUHP, Dharamshala- Member
7. Dr. Ritambhara Kumari Upadhyay, Department of Geology, School of Earth and Environmental Sciences, CUHP, Dharamshala- Special Invitee

The meeting started with a warm welcome and introduction by Prof. A.K. Mahajan, Head, Department of Geology. Setting a positive tone for the session, Prof. A.K. Mahajan acknowledged the attendees, expressed gratitude for their presence, and briefly stated the purpose of the meeting.

It was informed to the Committee that the Course structure and the course content have been modified keeping in view the NEP 2020 guidelines, which have been included in the agenda.

The point-wise discussion of the agenda, along with the resolutions of the Committee, is as follows:

Agenda Item No: GEO-BOS-2/26-1: To discuss the course basket for the MSc and PhD Geology

Resolved: The committee approved the course basket.

Agenda Item No. GEO-BOS-2/26-2: To discuss and approve the revised course structure (Annexure II and V) and course contents (Annexure III) of the M.Sc. Geology as per NEP 2020.

Resolved: The committee discussed, revised, and approved the course structure for MSc. Geology as per the NEP 2020 guidelines.

Naveen Chaudhri



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GEO-BOS-2/26-3:- To discuss and approve the revised course structure for one semester of coursework in the PhD in Geology

Resolved: The committee discussed, revised, and approved the course structure for the PhD. Geology as per the NEP 2020 guidelines.

GEO-BOS-2/26-4:- Any other matter with the Chairs approval

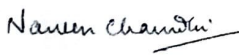
Resolved: The committee gave the following suggestions and recommendations:

1. The requirement for applications in PhD in Geology should be MSc in Geology or Earth Sciences and the other conditions will be same as per UGC norms.
2. The committee also approved the syllabus for entrance in PhD which will be the same as the syllabus for MSc Geology.

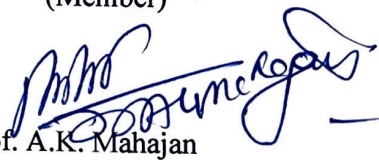

Dr. Kumar Batuk Joshi
(Member)


Prof. Rajesh Kumar
(VC Nominee)


Prof. Deepak Pant
(Member)


Prof. Naveen Chaudhri
(External Member)


Prof. Santosh Kumar
(External Member)


Prof. A.K. Mahajan
(Chairman)

Annexure I

Course Basket for MSc Geology and PhD Geology courses

Course Code	Name of Course	Credits
GEO 401	Physical Geology and Geomorphology	2
GEO 402	Crystallography, Mineralogy and Thermodynamics	2
GEO 403	Structural Geology and Tectonics	2
GEO 404	Igneous, Metamorphic and Sedimentary Petrology	4
GEO 405	Paleontology and Stratigraphy	2
GEO 406	Practical I- Physical Geology and Geomorphology, Crystallography, Mineralogy and Thermodynamics, Structural Geology and Tectonics	2
GEO 407	Practical II- Igneous, Metamorphic and Sedimentary Petrology, Paleontology and Stratigraphy	2
GEO 408	Indian Knowledge System	2
GEO 409a	Natural Hazards	2
GEO 410	Elemental and Isotope Geochemistry	4
GEO 411	Engineering Geology	2
GEO 412	Ore Geology	2
GEO 413	Practical-III: Elemental and Isotope Geochemistry, Engineering Geology, Ore Geology	2
GEO 414	Indian Traditional Knowledge System	2
GEO 415b	Fundamentals in Gemology	2
GEO 415a	Geo-Environmental Impacts of Mining with Special Reference to the Himalayan Region	2
GEO 416	Geological Field Training-Mapping	2
GEO 417	Internship/Industrial training	2
GEO 418	Natural Hazard and Disaster Management	4
GEO 419	Exploration and Mining Geology	2
GEO 420	River Science System	2
GEO 421	Forensic Geology	2
GEO 422	Geothermal Energy	2
GEO 423	Glaciology	2
GEO 424	Fuel Geology	2
GEO 425	Gemstones- Colored Stones	4
GEO 426	Gemstones-Diamonds	2
GEO 427	Gemstones-Pearls	2

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	Evolution of the Continental Crust	2
GEO 428		2
GEO 429	Stratigraphy	2
GEO 430	Igneous Petrology	2
GEO 431	Metamorphic Petrology	2
GEO 432	Sedimentary Petrology	2
GEO 433	Climatology	2
GEO 434	Oceanography	2
GEO 435	Quaternary Geology	2
GEO 436	Earth System Science	2
GEO 437	Paleontology	2
GEO 438	Paleoclimate	2
GEO 439	Igneous and Metamorphic Petrology	4
GEO 440	Paleoceanography	2
GEO 441	Practical-IV: Elemental and Isotope Geochemistry, Ore Geology and Sedimentary Petrology	2
GEO 442	Swayam Course	2
GEO 443	Practical V- Igneous and Metamorphic and Petrology, Paleontology and Stratigraphy	
GEO 501	Climatology and Oceanography	4
GEO 502	Literature Review and research Proposal-Theory	4
GEO 503	Literature Review and Research Proposal-Project	4
GEO 504	Geohydrology and Water Resource Management	4
GEO 505	Research Methodology	4
GEO 506	Geological Field	2
GEO 507	Quaternary Geology and Paleoclimate	4
GEO 508	Analytical Petrology & Geochemistry	4
GEO 509	Advanced Igneous Petrology	4
GEO 510	Advanced Remote Sensing and GIS applications	4
GEO 511	Chemical Petrology and Geodynamics	4
GEO 512	Research proposal	2
GEO 513	Practical (Paper Publications/Seminar-Conference presentation at national level	2
GEO 514	Academic writing	2
GEO 515	Composition and Evolution of Continental Crust	4
GEO 516	Fundamentals of Climate and Ocean	2
GEO 517	Gemology	2
GEO 518	Paleoclimate and Paleoceanography	4
GEO 519	Research Methodology in Geology	4
GEO 520	Fieldwork	2
GEO 521	Advanced Metamorphic Petrology	
GEO 522	Advanced Sedimentary Petrology	4
GEO 523	Advanced Vertebrate Paleontology	4

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GEO 524	Advanced Invertebrate Paleontology	4
GEO 525	Gemstones-Colored Stones and Diamonds	4
GEO 599	Dissertation and Viva Voce	8
PhD Courses		
GEO 601	Research Methodology	4
GEO 602	Research And Publication Ethics	2
GEO 603	Literature Review and Scientific Writing	2
GEO 604	Geology and Tectonics of India	2
GEO 605	Teaching Pedagogy	2
GEO 606	Bhartiya Traditional Knowledge and Practices	2
GEO 607	Igneous Petrology	2
GEO 608	Geohydrology	2
GEO 609	Remote Sensing and GIS Application in Geosciences	2
GEO 610	Structural Geology	2
GEO 611	Sedimentology	2
GEO 612	Volcanology and Geothermal Energy	2
GEO 613	Paleontology	2
GEO 614	Paleoclimate	2
GEO 615	Micropaleontology	2
GEO 616	Tectonic Geomorphology	2
GEO 617	Isotope Geochemistry	2
GEO 618	Crustal Evolution	2
GEO 619	Analytical Geochemistry	2
GEO 699	PhD Thesis	8

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Annexure-II

MSc. Geology (2025-2027)

List of Semester-wise Core Courses (Compulsory and Elective)

Semester	Credits	Compulsory	Credits	Credits	Elective/Optional/IDC Courses	Credits
I	16	GEO 401: Physical Geology and Geomorphology	02	04 (Choose any one IDC)	GEO 408: Indian Knowledge System	02
		GEO-402: Crystallography, Mineralogy and Thermodynamics	02		GEO 409a: Natural Hazards (IDC)	02
		GEO 403: Structural Geology and Tectonics	02		GEO 415b: Fundamentals in Gemology (IDC)	02
		GEO 404: Igneous, Metamorphic and Sedimentary Petrology	04			
		GEO 405: Paleontology and Stratigraphy	02			
		GEO 406: Practical I- Physical Geology and Geomorphology, Crystallography, Mineralogy and Thermodynamics, Structural Geology and Tectonics	02			
		GEO 407: Practical II- Igneous, Metamorphic and Sedimentary Petrology, Paleontology and Stratigraphy	02			
Semester	Credits	Compulsory	Credits	Credits	Elective/Optional/IDC Courses	Credits
II	16	GEO 410: Elemental and Isotope Geochemistry	04	04 (Choose any one IDC)	GEO 415a: Geo-Environmental Impacts of Mining with Special Reference to the Himalayan Region (IDC)	02
		GEO 411: Engineering Geology	02		GEO 426: Gemstones-Diamonds (IDC)	02
		GEO 412: Ore Geology	02		GEO 442: Swayam Course (Swayam course/IDC)	02
		GEO 413: Practical-III: Elemental and Isotope Geochemistry, Engineering Geology, Ore Geology	02		GEO 414: Indian Traditional Knowledge System	02
		GEO 416: Geological Field Training	02			
		GEO 418: Hazard and Disaster Management	04			

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Semester	Credits	Compulsory	Credits	Credits	Specialized Elective	Credits
III	16	GEO 502: Literature Review and Research Proposal-Theory	04	04 (Choose any one Specialized elective)	GEO 504: Geohydrology and Water Resource Management	04
		GEO 503: Literature Review and Research Proposal-Project	04		GEO 515: Composition and Evolution of Continental Crust	04
		GEO 519: Research Methodology in Geology	04			
		GEO 516: Fundamentals of Climate and Ocean	02			
		GEO 517: Gemology	02			
Semester	Credits	Compulsory	Credits	Credits	Specialized Elective	Credits
IV	16	GEO 508: Analytical Petrology & Geochemistry	04	04 Choose any one Specialized elective)	GEO 509: Advanced Igneous Petrology	04
		GEO 513: Practical (Paper Publications/Seminar-Conference presentation at national level	02		GEO 510: Remote Sensing and GIS applications	04
		GEO 514: Academic writing	02			
		GEO 599: Internship and Field/ Lab-oriented dissertation	08			

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Annexure V

MSc. Geology (2026-2028)

List of Semester-wise Core Courses (Compulsory and Elective)

Semester	Credits	Compulsory	Credits	Credits	Elective/Optional/IDC Courses	Credits			
I	16	GEO 401: Physical Geology and Geomorphology	02	04 (Choose any one IDC)	GEO 408: Indian Knowledge System	02			
		GEO-402: Crystallography, Mineralogy and Thermodynamics	02		GEO 409a: Natural Hazards (IDC)	02			
		GEO 403: Structural Geology and Tectonics	02		GEO 415b: Fundamentals in Gemology (IDC)	02			
		GEO 439: Igneous and Metamorphic Petrology	04						
		GEO 405: Paleontology and Stratigraphy	02						
		GEO 406: Practical I- Physical Geology and Geomorphology, Crystallography, Mineralogy and Thermodynamics, Structural Geology and Tectonics	02						
		GEO 443: Practical V- Igneous and Metamorphic Petrology, Paleontology and Stratigraphy	02						
		Semester Credits			Compulsory Credits	Credits	Elective/Optional/IDC Courses	Credits	
		II	16		GEO 410: Elemental and Isotope Geochemistry	04	04 (Choose any one IDC)	GEO 415a: Geo-Environmental Impacts of Mining with Special Reference to the Himalayan Region (IDC)	02
					GEO 411: Engineering Geology	02		GEO 426: Gemstones-Diamonds (IDC)	02
GEO 412: Ore Geology	02			GEO 442: Swayam Course (Swayam course/IDC)	02				
GEO 441: Practical-IV: Elemental and Isotope Geochemistry, Ore Geology and Sedimentary Petrology	02			GEO 414: Indian Traditional Knowledge System	02				
GEO 432: Sedimentary Petrology	02								
GEO 418: Hazard and Disaster Management	04								

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Semester	Credits	Compulsory	Credits	Credits	Specialized Elective	Credits
III	16	GEO 502: Literature Review and Research Proposal-Theory	04	04 (Choose any one specialised elective)	GEO 504: Geohydrology and Water Resource Management	04
		GEO 503: Literature Review and Research Proposal-Project	04		GEO 515: Composition and Evolution of Continental Crust	04
		GEO 519: Research Methodology in Geology	04			
		GEO 516: Fundamentals of Climate and Ocean	02			
		GEO 517: Gemology	02			
Semester	Credits	Compulsory	Credits	Credits	Specialized Elective	Credits
IV	16	GEO 508: Analytical Petrology & Geochemistry	04	04 (Choose any one specialised elective)	GEO 509: Advanced Igneous Petrology	04
		GEO 513: Practical (Paper Publications/Seminar-Conference presentation at national level	02		GEO 510: Remote Sensing and GIS applications	04
		GEO 514: Academic writing	02			
		GEO 599: Internship and Field/ Lab-oriented dissertation	08			

Annexure-IV

PhD Course in Geology

	Credits	Courses	Credits
PhD Coursework	16	GEO 601: Research Methodology	04
		GEO 602: Research and Publication Ethics	02
		GEO 603: Literature Review and Scientific Writing	02
		GEO 605: Teaching Pedagogy	02
		GEO 606: Bhartiya traditional Knowledge and practices	02
		Research Course*	Credit
		GEO 607: Igneous Petrology	02
		GEO 608: Geohydrology	02
		GEO 609: Remote Sensing and GIS applications in Geoscience	02
		GEO 617: Isotope Geochemistry	02
		GEO 618: Crustal Evolution	02
		GEO 619: Analytical Geochemistry	02

Research Course*- Any two to be opted

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**MSc GEOLOGY SYLLABUS FOR
CENTRAL UNIVERSITY OF HIMACHAL PRADESH,
DHARAMSHALA, HIMACHAL PRADESH**

Documents attached on all the pages 1 to 96 are approved

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Program Outcomes: At the end of the MSc Geology program, the students will be able to:

PO1: Recall and describe fundamental concepts of Earth systems, minerals, rocks, structures, and stratigraphy.

PO2: Classify and illustrate geological materials, landforms, fossils, and structural features using field and laboratory observations.

PO3: Execute and interpret geoscientific techniques, including petrography, geochemical analysis, remote sensing, and GIS applications.

PO4: Examine and differentiate tectonic processes, geomorphic systems, and stratigraphic sequences in diverse geological settings.

PO5: Assess and critique geological data for resource evaluation, environmental management, and geohazard mitigation.

PO6: Formulate and develop scientific models for petrogenesis, basin evolution, and crustal processes.

PO7: Construct and defend research outputs, including reports, publications, and presentations, adhering to professional and ethical standards.

The semester-wise syllabus for MSc Geology is as follows:

Semester I

GEO 401: Physical Geology and Geomorphology

Credits:2

Course No:	Course Name: Physical Geology and Geomorphology				Course Code: GEO 401		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2 Total Hrs.: 30
			2	0	0	2	
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective: The objective of this course is to provide students with a foundational understanding of the Earth's physical structure, the materials composing it, and the dynamic processes that shape its surface over time. The course emphasizes the principles of **physical geology**, including mineralogy, petrology, plate tectonics, and Earth's internal processes, as well as **geomorphology**, focusing on landform development, surface processes, and the interpretation of landscapes. Students will develop the skills to analyze geologic features,



understand the evolution of Earth's surface, and apply geomorphic principles to real-world environmental and geohazard problems.

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

CO1: define fundamental geological concepts and **explain** the structure, composition, and evolution of the Earth, including plate tectonics and seismic wave propagation and assess their implications in understanding geohazards and Earth system processes.

CO2: identify minerals and classify rocks, and **apply** rock cycle principles to understand formation and weathering processes, and evaluate their significance in resource utilization and environmental sustainability.

CO3: analyze landforms using geomorphic principles, and **interpret** geomorphic cycles and morphogenetic regions, and formulate geomorphic inferences for landscape evolution and hazard assessment.

CO4: assess the effects of exogenic processes (fluvial, aeolian, glacial, coastal, karst, and mass wasting) on landscape evolution, and **evaluate** their environmental and engineering implications.

CO5: construct tectonic and volcanic geomorphological models, and **develop** applied geomorphological maps and GIS-based interpretations for resource, hazard, and infrastructure planning.

Course Content:

Unit I: Fundamentals of Physical Geology; Introduction to Geology: Scope and branches; Origin of the Earth and solar system: Nebular hypothesis, Planetesimal theory; Structure and composition of Earth: Crust, mantle, core; Earth's magnetic field and gravity anomalies; Geological time scale: Concepts of deep time, major geological events; Plate tectonics and continental drift; Seismic waves and Earth's interior exploration

Unit II: Definition, physical and chemical properties of minerals; Classification of rocks: Igneous, sedimentary, metamorphic; Processes of rock formation: Crystallization, sedimentation, metamorphism; Rock cycle and its significance; Economic significance of rocks and minerals; Weathering and erosion of rocks: Physical, chemical, and biological

Unit III: Introduction to Geomorphology; Definition, scope, and significance of Geomorphology; Fundamental concepts: Uniformitarianism, Catastrophism, Isostasy; Geomorphic cycles: Davisian cycle, Penck's theory, King's model; Types of landforms: Structural, depositional, and erosional; Concept of morphogenetic regions

Unit IV: Exogenic Processes and Associated Landforms; Fluvial processes and landforms: River erosion, transportation, and deposition; Aeolian processes and desert geomorphology; Glacial processes and glacial landforms; Karst processes and landforms: Solution processes,



caves, sinkholes; Coastal geomorphology: Wave action, coastal erosion, beaches, spits, bars; Mass wasting processes: Landslides, mudflows, debris flows

Unit V: Endogenic Processes, Applied Geomorphology & Techniques; Volcanism: Types of volcanoes, volcanic landforms; Earthquakes and associated geomorphic features; Tectonic geomorphology: Fault scarps, rift valleys, folded mountains; Applied geomorphology: Role in engineering geology, hydrology, and resource exploration; Remote sensing and GIS in geomorphological studies; Principles of geomorphological mapping and interpretation

Recommended Readings:

- "Essentials of Geology" by Frederick K. Lutgens, Edward J. Tarbuck, and Dennis G. Tasa
- "The Dynamic Earth: An Introduction to Physical Geology" by Brian J. Skinner and Stephen C. Porter
- "Understanding Earth" by John Grotzinger and Thomas H. Jordan
- "Foundations of Earth Science" by Frederick K. Lutgens and Edward J. Tarbuck
- "Earth: An Introduction to Physical Geology" by Edward J. Tarbuck, Frederick K. Lutgens, and Dennis G. Tasa
- Geoinformatics in Applied Geomorphology. Anbazhagan, S.; Subramanian, S. K. and Yang X., CRC Press, Taylor & Francis Group, London and New York 2011
- Geomorphology and Global Environmental Change. Slaymaker, O.; Spencer, T. and Hamann, C.E., Cambridge University Press, New York 2009
- Fundamentals of geomorphology. Huggett, R. J., Routledge, Taylor & Francis Group, New York 2007
- Seismic Geomorphology: Application to hydrocarbon exploration and production. Davies, R.J.; Posamentier, H.W.; Wood, L. J. and Cartwright J.A., The Geological Society of London. 2007
- Applied Geomorphology. Allison, R.J, John Wiley and Sons Ltd. England 2002

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	2	1	2	–	1
CO3	1	2	3	3	2	2	1
CO4	–	1	2	3	3	1	–
CO5	–	1	3	2	2	3	2



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 11, SDG 13, SDG 15
CO2	SDG 12, SDG 13, SDG 15
CO3	SDG 11, SDG 13, SDG 15
CO4	SDG 9, SDG 13, SDG 15
CO5	SDG 9, SDG 11, SDG 13

402: Crystallography, Mineralogy and Thermodynamics

Credits:2

Course No:	Course Name: Crystallography, Mineralogy and Thermodynamics				Course Code: GEO 402		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to provide students with a foundational understanding of minerals, their physical and chemical properties, classification, and crystallographic characteristics. The course emphasizes the study of crystal structures, symmetry, crystal systems, and the internal arrangement of atoms in minerals. Students will learn techniques for mineral identification in hand specimens and thin sections, and develop the ability to interpret crystallographic data and use it to understand mineral formation and behaviour.

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

CO1: define symmetry elements, crystal systems, classes, and Miller indices, and **explain** crystal lattices, Bravais lattices, and twinning in crystals, and assess their significance in mineral identification and crystallographic interpretation.

CO2: apply concepts of space groups, unit cells, and Bragg's Law, and **demonstrate** interpretation of XRD patterns for mineral identification, and evaluate the reliability of analytical results in mineral characterization.



CO3: analyze structural, chemical, and polymorphic variations of silicate mineral groups and **differentiate** their modes of occurrence, stability, and alterations under varying pressure-temperature conditions, and formulate interpretations for mineral stability and geochemical evolution.

CO4: evaluate optical properties of minerals using plane-polarized and cross-polarized light, interference figures, and advanced techniques, and **assess** the utility of SEM and EPMA in mineral characterization.

CO5: formulate phase diagrams and activity-composition relationships and **design** models to predict mineral stability, metamorphic reactions, and geochemical processes.

Course Content:

Unit I: Fundamentals of Crystallography; Symmetry elements: Plane, axis, center; Crystal systems and their classification; Crystal classes and 32 point groups; Miller indices and their significance; Crystal lattices and Bravais lattices; Forms, zones, and twinning in crystals.

Unit II: Advanced Crystallography & X-ray Crystallography; Space groups and symmetry operations; Concept of unit cell and crystal structures; Introduction to X-ray crystallography; Bragg's Law and its applications; Powder and single-crystal diffraction methods; Interpretation of X-ray diffraction (XRD) patterns; Applications of crystallographic techniques in mineral identification

Unit III: A detailed study of the important silicate mineral groups (listed below) with reference to general and structural formulae, classification atomic structure, polymorphs/structural states, chemistry including substitution of elements/solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations.

a) Nesosilicates: Olivine Group, Garnet Group, Aluminosilicate Group (Kyanite, Andalusite and Sillimanite).

b) Cyclosilicates: Beryl

c) Inosilicates; Pyroxene Group; Amphibole Group.

d) Phyllosilicates: Kaolinite Group, Serpentine Group, Pyrophyllite, Talc, Mica Group, Chlorite.

e) Tectosilicate: Feldspar Group, Cordierite.

Unit IV: Optical Mineralogy and Techniques; Principles of optical mineralogy; Properties of minerals in plane-polarized light and crossed polars; Interference figures and optical classification: Uniaxial, biaxial minerals; Determination of extinction angles, birefringence, pleochroism; Use of polarizing microscope; Introduction to advanced techniques: SEM, EPMA.

Unit V: Thermodynamics of Geological Processes; Introduction to thermodynamics: Systems, states, and processes; First, second, and third laws of thermodynamics; Gibbs free energy and its significance in geological systems; Phase rule and phase diagrams: One-component and



binary systems; Activity-composition relationships in minerals; Mineral stability, metamorphic reactions, and P-T diagrams; Application of thermodynamics in petrology and geochemistry

Recommended Readings:

- Berry, L.G., Mason, B. and Dietrich, R.V. (1985) Mineralogy: Concepts, Descriptions and determinations. CBS Publishers
- Dana, E.S. and Ford, W.E. (2002) A text book of Mineralogy (Reprint)
- Deer, W.A., Howie, R.A. & Zussman, J. (2013): An Introduction to the rock forming minerals, ELBS and Longman
- Gribble C.D. (2005) Rutley's elements of Mineralogy, Springer.
- Kerr, P.F (1977) : Optical Mineralogy McGraw Hill • Nesse, D.W (1986) : Optical Mineralogy, McGraw Hill
- Perkins, D. (2013) Mineralogy, Prentice Hall • Phillips, F.C (1971) . Introduction to Crystallography. Longman Group Publication.
- Reed, S.J. B. (1996) Electron Microprobe Analysis and Scanning electron Microscopy in Geology, Cambridge University press.
- Sharma, R.S. and Sharma, A. (2013): Crystallography and Mineralogy- concepts and methods. Geological Society of India
- Winchell, E.N (1951) .: Elements of Optical Mineralogy, Wiley Eastern.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: 3 = **High**, 2 = **Moderate**, 1 = **Low**, – = **no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	1	2	3	2	2	–	1
CO3	1	2	3	3	2	2	1
CO4	–	1	2	2	3	1	1
CO5	–	1	2	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 12
CO2	SDG 9, SDG 12
CO3	SDG 12, SDG 13, SDG 15



Course Outcome (CO)	Mapped SDGs
CO4	SDG 9, SDG 12
CO5	SDG 9, SDG 12, SDG 13

GEO 403: Structural Geology and Tectonics

Credits:2

Course No:	Course Name: Structural Geology and Tectonics				Course Code: GEO 403		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective: The objective of this course is to provide students with a detailed understanding of the principles and processes of structural geology, including the formation and analysis of geological structures such as folds, faults, joints, and foliations. The course emphasizes the mechanics of rock deformation, techniques for structural mapping, and interpretation of structural data in both two and three dimensions. It aims to develop the skills necessary to analyze and solve geological problems related to tectonics, basin development, and crustal evolution using maps, cross-sections, and stereographic projections.

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

CO1: define basic concepts of stress, strain, and rock deformation, and **explain** outcrop patterns and attitude measurements using a compass-clinometer, and assess their implications in structural interpretation and geotechnical applications.

CO2: identify primary and secondary structures in the field and **apply** classification schemes for bedding, foliation, and lineation in geological mapping, and evaluate their significance in tectonic analysis and resource exploration.

CO3: analyze fold geometries and types, and **interpret** their field and map expressions in terms of tectonic processes, and formulate structural models for deformation history and crustal evolution.



CO4: assess fault and joint characteristics in different geological settings, and **evaluate** their significance in distinguishing structural features from unconformities.

CO5: **construct** geological cross-sections and block diagrams, and **develop** integrated models of tectonic evolution of the Indian subcontinent.

Course Content:

Unit I: Introduction to Structural Geology; Scope, significance, and applications of structural geology; Concept of rock deformation: Elastic, brittle, ductile behavior; Stress and strain in geological materials; Outcrop patterns and attitude of beds: Strike, dip, apparent dip; Use of compass-clinometer in structural measurements

Unit II: Primary and Secondary Structures; Primary sedimentary structures: Bedding, ripple marks, cross-bedding; Secondary planar structures: Foliation, cleavage, schistosity; Secondary linear structures: Lineation, mineral lineation, intersection lineation; Relation between foliation, lineation, and folds

Unit III: Folds; Geometry and classification of folds; Fold terminology: Hinge, limb, axial plane, plunge; Types of folds: Symmetrical, asymmetrical, overturned, recumbent, isoclinal, chevron; Mechanics and causes of folding; Recognition of folds in the field and on geological maps.

Unit IV: Faults and Joints; Faults: Types (normal, reverse, thrust, strike-slip), classification and recognition criteria; Fault plane features: Slickensides, fault breccia, drag folds; Joints and fractures: Classification and geological significance; Distinguishing between faults and unconformities in the field

Unit V: Tectonics and Plate Movements; Plate tectonics: Lithospheric plates, boundaries, and types of plate margins; Continental drift and sea-floor spreading; Orogeny and mountain-building processes; Concept of isostasy and geosynclines; Tectonics of Indian subcontinent: Himalayan orogeny, Indian plate evolution

Recommended Readings:

- Davis, G.H. and Reynolds, S. J. Structural geology of rocks and regions. 2011
- Fossen, H. Structural Geology. Cambridge University Press. London. 2010
- Ragan, D. M. Structural Geology. Cambridge University Press. London. 2009
- Ramsay, J.G. and Lisle, R. The Techniques of Modern Structural Geology, Vol. 3. Application of Continuum Mechanics in Structural Geology, Academic Press, London. 2000
- Marshak S. and Mitra S. Basic methods in structural geology. 1988
- Ramsay, J. G. and Huber, M. I. The Techniques of Modern Structural Geology, Vol. 1. Strain Analysis, Academic Press, London. 1983
- Jaeger, J. C. and Cook, N. G .W. Fundamentals of rock mechanics. Methuen, London, 593p 1979



- Ramsay, J. G. Folds and fractures. Mc-Graw Hills, NY 1967

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	2	1	2	–	1
CO3	1	2	3	3	2	2	1
CO4	–	1	2	3	3	1	1
CO5	–	1	3	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 11
CO2	SDG 9, SDG 12
CO3	SDG 9, SDG 13, SDG 15
CO4	SDG 9, SDG 11, SDG 13
CO5	SDG 9, SDG 11, SDG 13

GEO 404: Igneous, Metamorphic and Sedimentary Petrology

Credits:4



Course No:	Course Name: Igneous, Metamorphic and Sedimentary Petrology				Course Code: GEO 404		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the origin, classification, and evolution of igneous, metamorphic, and sedimentary rocks. The course aims to develop the ability to identify rock types in hand sample and thin sections, understand the physical and chemical processes involved in their formation, and interpret their geological significance in the context of Earth's history and tectonic settings. Emphasis is placed on mineralogical composition, textures, classification schemes, and field relations, as well as laboratory techniques used in petrographic analysis.

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

CO1: define classifications, textures, and structures of igneous, metamorphic, and sedimentary rocks, and **explain** weathering and soil-forming processes and diagenetic changes, and assess their implications in geological interpretation and resource evaluation.

CO2: apply thermodynamic principles and the phase rule to metamorphic and sedimentary systems, and **demonstrate** the identification of stable mineral assemblages and metamorphic facies, and evaluate the reliability of petrological interpretations in geological studies.

CO3: analyze major and trace element data for petrogenetic interpretations, and **differentiate** between depositional environments and metamorphic reactions of pelitic and mafic rocks, and formulate petrogenetic models for crustal evolution and basin development.

CO4: evaluate geological significance of layered mafic intrusions, flood basalts, granitoid and alkaline rocks, and **assess** sedimentary environments including marginal marine and siliclastic marine settings.

CO5: formulate models for the origin and evolution of anorthosites, gabbroic, ultramafic, and volcanic rocks, and **design** frameworks to understand metamorphic fluids, metasomatism, and carbonate-evaporite environments.



Course Content:

Unit I: Some fundamental concepts; Classification and Nomenclature of Igneous Rocks; Textures of Igneous rocks; Introduction to metamorphism; Classification of Metamorphic rocks; Igneous structures and field relationships Structures and textures of Metamorphic rocks; Subaerial weathering processes; submarine weathering processes; soil forming processes; Sedimentary textures and structures; Composition, Classification and Diagenesis of sedimentary rocks

Unit II: Introduction to thermodynamics, Phase rule; one and two component systems; systems with more than two components; Stable mineral assemblages in metamorphic rocks; Metamorphic facies; Siliclastic sedimentary rocks; Carbonate sedimentary rocks

Unit III: Major and trace elements; using trace element data for petrogenesis of Igneous rocks; Diversification of magmas; metamorphosed mafic rocks; Metamorphic reactions; Metamorphism of pelitic sediments; Chemical/Biochemical and carbonaceous sedimentary rocks; Depositional environments: Continental Environments;

Unit IV: Layered mafic intrusions; continental flood basalts; granitoid rocks; Alkaline rocks; metamorphism of calcareous and ultramafic rocks; Marginal Marine environments; Siliclastic marine environments;

Unit V: Anorthosites; Gabbroic rocks; Ultramafic and ultra basic rocks; andesite, dacite rhyolite; pyroclastic products; metamorphic fluids, mass transport and metasomatism; carbonate and Evaporite environments

Recommended Readings:

- Philpotts, A.R. and Ague, J.J., "Principles of Igneous and Metamorphic Petrology" Cambridge University Press 2010
- Winter, J., "An Introduction to Igneous and Metamorphic Petrology", Prentice-Hall 2001
- Hall, A., "Igneous Petrology", John Wiley & Sons 1995
- Rollinson, H., "Using geochemical data: evolution, presentation, interpretation" Pearson Education Limited 1993
- Willson, M., "Igneous Petrogenesis: A Global Tectonic Approach", UnwinHyman 1989
- Cox, K.G., Bell, J.D. and Pankhurst, R.J., "The Interpretation of Igneous Rocks" George Allen and Unwin Publishers Ltd. 1979
- Spear, F.S., "Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths", Mineralogical Society of America Monograph 1993
- Kornprobst, J., "Metamorphic Rocks and their Geodynamic Significance: A Petrological Handbook", Springer 2002
- Vernon, R.H and Clarke, G., "Principles of Metamorphic Petrology", Cambridge University Press 2008
- Winter, J.D., "Principles of Igneous and Metamorphic Petrology", Prentice Hall 2009



- Bucher, K. and Grapes, R., “Petrogenesis of Metamorphic Rocks”, Springer 2011
- Nichols, G.: Sedimentology and stratigraphy, 2nd Ed. WileyBlacwell 2009
- Boggs, Sam (Jr.): Principles of Sedimentology and Stratigraphy, 4th Ed. Pearson/Prentice Hall. 2006
- Allen, P.A. and Allen, J.R.: Basin Analysis: Principles and applications. Blackwell publishing 2005
- Van Loon A.J.: Cyclic development of sedimentary basins. Elsevier. 2005
- Reading, H.G.: Sedimentary Environments and Facies. 6th Ed., Blackwell Scientific Publ., Oxford. 1996.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	1	2	3	2	2	–	1
CO3	1	2	3	3	2	2	1
CO4	–	1	2	2	3	1	1
CO5	–	1	2	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 12, SDG 15
CO2	SDG 9, SDG 12, SDG 13
CO3	SDG 12, SDG 13, SDG 15
CO4	SDG 9, SDG 12, SDG 13
CO5	SDG 12, SDG 13, SDG 15

GEO 405: Paleontology and Stratigraphy

Credits:2

Course No:	Course Name: Paleontology and Stratigraphy				Course Code: GEO 405		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30



Evaluation Criteria

- **Total Evaluation Mark: 100**
- **Mid-Term Examination (20%): 20**
- **End-Term Examination (60%): 60**
- **Continuous Internal Assessment (20%): 20**

Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the principles and applications of stratigraphy and paleontology. The course aims to introduce the concepts of rock layering, correlation, geological time scale, and depositional environments, as well as the study of fossils and their significance in interpreting Earth's history. Emphasis is placed on biostratigraphy, lithostratigraphy, chronostratigraphy, and the evolutionary history of life through the fossil record.

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

CO1: define fundamental stratigraphic principles, including litho-, bio-, and chrono-stratigraphy, and **explain** the applications of fossils in taphonomy, functional morphology, and evolutionary studies, and assess their significance in geological correlation and paleoenvironmental interpretation.

CO2: apply chronostratigraphic concepts to interpret Precambrian cratons of India and **illustrate** modes of fossil preservation, microevolution, macroevolution, and paleoecological patterns, and evaluate their implications for reconstructing Earth history and basin evolution.

CO3: analyze stratigraphic sequences of the Cuddapah, Vindhyan, and Godavari Supergroups, and **differentiate** morphological and evolutionary trends in bivalves, gastropods, cephalopods, and brachiopods, and formulate stratigraphic and evolutionary interpretations for regional geological frameworks.

CO4: evaluate paleogeography, paleoclimate, and depositional characteristics of Gondwana and Mesozoic systems, and **assess** the significance of flora, fauna, ichnofossils, and microfossils in evolutionary reconstructions.

CO5: formulate stratigraphic frameworks for the Deccan Traps and Cenozoic systems, and **design** evolutionary models for vertebrate lineages, including Equidae, Proboscidae, and the evolution of humans.

Course Content:

Unit I: Approaches to measurement of geological time; Stratigraphic Principles and concept of Litho-, Bio- and Chrono-Stratigraphy, brief idea about sequence, magneto- seismic- chemo- and event stratigraphy; Stratigraphic correlations; Development of Time Scale.



Application of fossils; Applications of fossils, Species concept, Darwin, Species and natural Selection, taphonomy, Events in taphonomic history, functional morphology, Ichnology; graphic correlation

Unit II: Precambrian chronostratigraphy of Aravalli craton, Dharwar craton, Eastern Ghats mobile belt, Bastar craton, Southern Granulite belt and Singhbhum craton.

Theory and rate of evolution and extinction, the species and Natural selection; mode of preservation of fossils; nature of fossil record and mode of evolution, microevolution, macroevolution; paleoecology; food chain in marine ecosystem

Unit III: Stratigraphy of Cuddapah, Vindhyan, **Supergroup** and their equivalents; Precambrian/Cambrian boundary.

Brief morphology and evolutionary trends in Bivalves, Gastropods, Cephalopods, Brachiopods, their modes of preservation and significance.

Unit IV: Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, depositional characteristics and igneous activities; Classification, depositional characteristics, fauna, and flora of Triassic, Jurassic and Cretaceous systems in major basins of India

Brief morphology and evolutionary trends in Echinoids, Graptoloides and Trilobites; Ichnofossils, their modes of preservation and significance. Gondwana flora; Ediacara fauna; microfossils-foraminifera

Unit V: Stratigraphy of Deccan Trap, Permian/Triassic boundary. Classification, depositional characteristics, fauna, and flora of the Palaeogene, Neogene and Quaternary systems and their equivalents in India; Epoch boundaries of the Cenozoic in India. Cretaceous/Tertiary boundary. Paleogene/ Neogene boundary.

Vertebrate sequence through time; Evolutionary changes in Equidae; Proboscidae; Evolution of Man.

Recommended Readings:

- Walton, J., "An Introduction to the Study of Fossil Plants", Adam & Charles Black 1953
- Woods, H., "Paleontology Invertebrate", CBS Publications 1963
- Haq B. U. and Boersma, A., "Introduction to Marine Micropaleontology", Elsevier. 1978
- Braiser, M.D., Microfossils, Geogrgre Alien and Unwin Publisher. 1980
- Benton, M.J., "Vertebrate Paleontology", Chapman & Hall 1997
- Jones, R. W., 1996. Micropaleontology in Petroleum exploration, Clarendon Press Oxford. 1998
- Colbert, R.L., "Paleontology", John Willey & Sons 1987
- Milsom, C., and Rigby, S., "Fossils at a Glance", Blackwell 2004
- McGowran, B., "Biostratigraphy: Microfossils & Geological Time", Cambridge University Press 2005
- Michel F. and Arnold I. Miller, David M. Raup, Steven M. Stanley "Principales of



- Paleontology”, W. H. Freeman, 2007
- Nichols, G.: Sedimentology and stratigraphy, 2nd Ed. WileyBlacwell 2009
 - Boggs, Sam (Jr.): Principles of Sedimentology and Stratigraphy, 4th Ed. Pearson/Prentice Hall. 2006
 - Catuneanu, O.: Principles of Sequence Stratigraphy. Elsevier. 2006
 - Allen, P.A. and Allen, J.R.: Basin Analysis: Principles and applications. Blackwell publishing 2005
 - Van Loon A.J.: Cyclic development of sedimentary basins. Elsevier. 2005
 - Brookefield, M.E.: Principles of Stratigraphy. Blackwell Publishing. 2004
 - Reading, H.G.: Sedimentary Environments and Facies. 6th Ed., Blackwell Scientific Publ., Oxford. 1996.
 - Raup, D. M and Stanley S. M. Principle of Paleontology, 2nd edition. CBS publishers
 - Clarkson E.N.K. Invertebrate paleontology and Evolution.
 - Ramakrishnan, M. and Vaidyanadhan, R., 2008. *Geology of India* (Vol. 1, pp. 261-333). Bangalore: Geological Society of India.
 - Vaidyanadhan, R. and Ramakrishnan, M., 2010. *Geology of India* (Vol. 2, pp. 557-994). Bangalore: Geological Society of India.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	1	2	3	2	2	–	1
CO3	1	2	3	3	2	2	1
CO4	–	1	2	2	3	1	1
CO5	–	1	2	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13, SDG 15
CO2	SDG 4, SDG 13, SDG 15
CO3	SDG 12, SDG 13, SDG 15
CO4	SDG 12, SDG 13, SDG 15



Course Outcome (CO)	Mapped SDGs
CO5	SDG 4, SDG 13, SDG 15

GEO 406: Practical I- Physical Geology and Geomorphology, Crystallography, Mineralogy and Thermodynamics, Structural Geology and Tectonics

Credits:2

Course No:	Course Name: Practical I- Physical Geology and Geomorphology, Crystallography, Mineralogy and Thermodynamics, Structural Geology and Tectonics				Course Code: GEO 406		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L 0	T 0	P 0	Credits 2	Contact Hrs. per Week: 4 Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objective of this course is to introduce the students to different landform features and their analysis to interpret the genesis and tectonic evolution. This course will also introduce the students to different laboratory techniques pertaining to the crystals, mineral hand specimens and mineral thin sections. Furthermore, this course will acquaint the students about different field and laboratory techniques related to structural geology. It is also aimed to familiarize the students to different techniques related to geological mapping.

Course Outcomes: After completion of the course the students will be able to:

CO1: identify geomorphic features and drainage patterns from topographic maps, and **explain** river longitudinal profiles, SL index, and active tectonics using geomorphic indices, and critically assess their role in understanding Earth system processes and geohazard evaluation.

CO2: apply Remote Sensing and GIS techniques for geomorphological mapping and **construct** morphometric models of drainage basins and terrains, and critically evaluate their effectiveness for geological interpretation and environmental management.

CO3: analyze physical and optical properties of rock-forming minerals in hand specimens and thin sections, and **interpret** interference figures, Becke lines, refractive indices, birefringence



data, and critically assess mineralogical data for accurate geological and petrogenetic interpretation.

CO4: analyze physical and optical properties of rock-forming minerals in hand specimens and thin sections, and **interpret** interference figures, Becke lines, refractive indices, and birefringence data.

CO5: formulate geological maps, cross-sections, structure contour maps, and isopach/facies maps, and **design** solutions for structural problems using orthographic and stereographic projections.

Practicals- Physical Geology and Geomorphology:

Study of geomorphic models and topographic maps; Drainage basin morphometry; Longitudinal profile of rivers and SL index; Study of active tectonics from geomorphic indices; Geomorphological mapping using Remote Sensing and GIS

Practicals- Crystallography, Mineralogy and Thermodynamics:

Study of rock forming minerals in hand specimen and thin sections: Physical and optical properties of common rock forming minerals; Study of Becke line; Determination of refractive indices and birefringence; Pleochroism and Dichroism: Pleochroic scheme of tourmaline, biotite, hornblende, actinolite, glaucophane, hypersthene, aegirine, andalusite and other silicate minerals; Study of Interference figures of uniaxial and biaxial minerals and determination of optic sign; Conversions of oxide and element weight percentages; Calculation of mineral formulae.

Practicals- Structural Geology and Tectonics:

Interpretation of structure from hand specimen, photographs; Preparation and interpretation of geological maps and cross sections; Structure contour maps, isopach maps and other facies maps, balanced cross-section, their importance in unraveling the geological history; Structural problems concerning economic deposit based on orthographic and stereographic projections; Recording and plotting of the field data.

Field visits will form a vital component of this course, enabling students to gain first-hand exposure to natural geological settings. These excursions will help them understand geomorphological features, identify minerals, and interpret geological structures in real-world contexts. By bridging the gap between theory and practice, students will develop essential observational, analytical, and field-mapping skills. The experience will also enhance their ability to correlate classroom concepts with on-site geological evidence. Overall, these visits will foster experiential learning and deepen their appreciation of Earth processes.

Recommended Readings:

- A Key for Identification of Rock-forming Minerals in Thin Section - Andrew J. Barker, *CRC Press*
- A Practical Introduction to Optical Mineralogy - C. D. Gribble and A. J. Hall, Springer
- Atlas of Rock-Forming Minerals in Thin Section - W. S. MacKenzie and C. Guilford, *Routledge*



- Laboratory Manual of Geology - A. K. Sen, *Modern Book Agency, Kolkata*
- Practical approach to Crystallography and Mineralogy - R. N. Hota, *CBS Publishers*
- Rock-forming Minerals in Thin Section - H. Pichler, C. Schmitt-Riegraf and L. Hoke, *Chapman & Hall*
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K.H. Brodie, *CRC Press*
- A Manual of Problems in Structural Geology - N. W. Gokhale, *CBS Publishers*
- Atlas of Structural Geology - Soumyajit Mukherjee, *Elsevier*
- Basic Methods of Structural Geology - S. Marshak and G. Mitra, *Prentice Hall*
- Tools in Fluvial Geomorphology - G. Mathias Kondolf and Hervé Piégay, *Wiley Blackwell*

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: 3 = **High**, 2 = **Moderate**, 1 = **Low**, – = **no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	1	1
CO2	3	2	3	2	3	2	1
CO3	3	2	3	2	3	2	1
CO4	1	2	3	2	2	1	1
CO5	–	1	3	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 11, SDG 13, SDG 15
CO2	SDG 9, SDG 11, SDG 13
CO3	SDG 9, SDG 12
CO4	SDG 4, SDG 12
CO5	SDG 9, SDG 11, SDG 12



GEO 407: Practical II- Igneous, Metamorphic and Sedimentary Petrology, Paleontology and Stratigraphy

Credits:2

Course No:	Course Name: Practical II- Igneous, Metamorphic and Sedimentary Petrology, Paleontology and Stratigraphy				Course Code: GEO 407		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 4
			0	0	0	2	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objective of this course is to introduce the students to different types of rocks in hand specimen, thin section as well as in the field and also to introduce them to analyse various types of petrological data and interpret them. This is also aimed to introduce the students to study morphological characters of different invertebrate and micro fossils and plant fossils and correlation of different sections.

Course Outcomes: After completion of the course the students will be able to:

CO1: identify igneous, sedimentary, and metamorphic rocks in hand specimen and thin sections, and **explain** their textures, structures, and mineralogical composition using megascopic and microscopic observations.

CO2: apply CIPW norm calculations, ternary diagrams, and geochemical data to interpret provenance, and **demonstrate** grain-size analysis and plotting of sedimentary structures, and construct and present data-driven geological interpretations using appropriate graphical and analytical tools.

CO3: analyze morphological characters and modes of preservation of fossils, and **differentiate** invertebrate groups, trace fossils, microfossils, and significant Indian Gondwana and Paleogene flora, and develop and justify paleontological interpretations in a scientific framework.

CO4: evaluate sedimentary sequences, stratigraphic classifications, and correlations, and **assess** tectonic divisions, Gondwana provinces, and interpretations of sequence, magneto-, and seismic stratigraphy.



CO5: formulate integrated geological reports from petrological, paleontological, and stratigraphic data, and **design** paleogeographic maps and visual representations of basin evolution, and defend stratigraphic interpretations through structured scientific reporting.

Practicals- Igneous, Metamorphic and Sedimentary Petrology:

Megascopic and microscopic study of different igneous (syenite, pitchstone granite, diorite, pegmatite, rhyolite, basalt, andesite, trachyte, norite, diorite, pyroxenite, lamprophyre) sedimentary (shale, Breccia, limestone, conglomerate, sandstone, mudstone) and metamorphic rocks (gneiss, schist, slate, phyllite, marble, quartzite, amphibolite); Calculation of CIPW norms; Ternary diagrams, Presenting major and trace element data for Igneous and sedimentary rocks; Provenance estimate using geochemical data; Identification of heavy minerals under microscope; Grain-size analysis by sieving method; Plotting of size-distribution data as frequency and cumulative curves; sedimentary structures.

Practicals-Paleontology:

Study of modes of preservation of fossils; Study of morphological characters of important invertebrate fossils belonging to Brachiopoda, Bivalvia, Cephalopods, Arthropoda, Gastropoda, Echinoidea, Foraminifera; Study of important trace fossils and microfossils; Study of important Indian Gondwana and Paleogene flora; Paleogeographic maps.

Practicals Stratigraphy:

Pre-Cambrian sedimentary basins of India, Phanerozoic sedimentary basins of India, tectonic divisions of India; Gondwana Provinces in India; Exercises on stratigraphic classification and correlation, sequence, magneto and seismic stratigraphic interpretations.

Field visits will be an integral part of this course, providing students with essential hands-on experience in geological investigations. These excursions will enable them to study rocks and fossils in their natural settings, enhancing their understanding of Igneous, Metamorphic, and Sedimentary Petrology, as well as Paleontology and Stratigraphy. By observing field relationships, lithological variations, and fossil assemblages, students will learn to interpret Earth's geological history more effectively. The visits will bridge the gap between theoretical knowledge and practical application while fostering critical thinking and scientific inquiry. Overall, this experiential learning approach will strengthen their field skills and professional competence in geosciences.

Recommended Readings:

- A Practical Guide to Rock Microstructure - Ron H. Vernon, *Cambridge University Press*
- Atlas of Metamorphic Rocks and Their Textures - B. W. D. Yardley, W.S. MacKenzie and C. Guilford, *Prentice Hall*
- BGS Rock Classification Scheme Volume 1 Classification of igneous rocks -M. R. Gillespie and M. T. Styles, *British Geological Survey*
- Introduction to Metamorphic Textures and Microstructures - A. J. Barker, *Routledge*
- Laboratory Manual of Geology - A. K. Sen, *Modern Book Agency, Kolkata*
- Microtextures of Igneous and Metamorphic Rocks - J. P. Bard, *Springer*



- Petrography of Igneous and Metamorphic Rocks-Anthony R. Philpotts, *CBS Publishers*
- Practical Approach to Petrology - R. N. Hota, *CBS Publishers*
- Quantitative Textural Measurements in Igneous and Metamorphic Petrology - Michael D. Higgins, *Cambridge University Press*
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K.H. Brodie, *CRC Press*
- A Practical Approach to Sedimentology - Roy C. Lindholm, Springer
- Historical Geological Lab Manual - Pamela J. W. Gore, Wiley
- Interpreting Earth History: A Manual in Historical Geology - Scott Ritter and Morris Petersen, Waveland Press
- Practical Approach to Petrology - R. N. Hota, CBS Publishers
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K. H. Brodie, CRC Press
- Paleontology: A Practical Manual - L. Mahesh Bilwa, Studera Press
- Practical Manual in Palaeontology - V. Manivannan and K. Subramani, Vishal Publishing Co

PO-CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	2	1	1
CO2	2	2	3	2	2	2	3
CO3	2	2	3	3	2	2	3
CO4	1	1	2	3	3	2	3
CO5	–	1	3	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 12
CO2	SDG 4, SDG 9, SDG 12
CO3	SDG 4, SDG 13, SDG 15



Course Outcome (CO)	Mapped SDGs
CO4	SDG 12, SDG 13, SDG 15
CO5	SDG 4, SDG 9, SDG 12

GEO 439: Igneous and Metamorphic Petrology

Credits:4

Course No:	Course Name: Igneous and Metamorphic Petrology				Course Code: GEO 439		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the origin, classification, and evolution of igneous and metamorphic rocks. The course aims to develop the ability to identify rock types in hand sample and thin sections, understand the physical and chemical processes involved in their formation, and interpret their geological significance in the context of Earth's history and tectonic settings. Emphasis is placed on mineralogical composition, textures, classification schemes, and field relations, as well as laboratory techniques used in petrographic analysis.

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

CO1: define classifications, textures, and structures of igneous and metamorphic rocks, and **explain** their implications in geological interpretation and resource evaluation.

CO2: apply thermodynamic principles and the phase rule to Igneous and metamorphic systems, and **demonstrate** the identification of stable mineral assemblages and metamorphic facies, and evaluate the reliability of petrological interpretations in geological studies.

CO3: analyze major and trace element data for petrogenetic interpretations, and **differentiate** between metamorphic reactions of pelitic and mafic rocks, and formulate petrogenetic models for crustal evolution.



CO4: evaluate geological significance of layered mafic intrusions, flood basalts, granitoid and alkaline rocks, and **assess** the metamorphism of calcareous and ultramafic rocks

CO5: formulate models for the origin and evolution of anorthosites, gabbroic, ultramafic, and volcanic rocks, and **design** frameworks to understand metamorphic fluids and metasomatism.

Course Content:

Unit I: Some fundamental concepts; Classification and Nomenclature of Igneous Rocks; Textures of Igneous rocks; Introduction to metamorphism; Classification of Metamorphic rocks; Igneous structures and Field Relationships Structures and textures of Metamorphic rocks;

Unit II: Introduction to thermodynamics, Phase rule; one and two component systems; systems with more than two components; Stable mineral assemblages in metamorphic rocks; Metamorphic facies;

Unit III: Major and trace elements; using trace element data for petrogenesis of Igneous rocks; Diversification of magmas; metamorphosed mafic rocks; Metamorphic reactions; Metamorphism of pelitic sediments;

Unit IV: Layered mafic intrusions; continental flood basalts; granitoid rocks; Alkaline rocks; metamorphism of calcareous and ultramafic rocks

Unit V: Anorthosites; Gabbroic rocks; Ultramafic and ultra basic rocks; andesite, dacite rhyolite; pyroclastic products; metamorphic fluids, mass transport and metasomatism

Recommended Readings:

- Philpotts, A.R. and Ague, J.J., "Principles of Igneous and Metamorphic Petrology" Cambridge University Press 2010
- Winter, J., "An Introduction to Igneous and Metamorphic Petrology", Prentice-Hall 2001
- Hall, A., "Igneous Petrology", John Wiley & Sons 1995
- Rollinson, H., "Using geochemical data: evolution, presentation, interpretation" Pearson Education Limited 1993
- Willson, M., "Igneous Petrogenesis: A Global Tectonic Approach", UnwinHyman 1989
- Cox, K.G., Bell, J.D. and Pankhurst, R.J., "The Interpretation of Igneous Rocks" George Allen and Unwin Publishers Ltd. 1979
- Spear, F.S., "Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths", Mineralogical Society of America Monograph 1993
- Kornprobst, J., "Metamorphic Rocks and their Geodynamic Significance: A Petrological Handbook", Springer 2002
- Vernon, R.H and Clarke, G., "Principles of Metamorphic Petrology", Cambridge University Press 2008
- 4. Winter, J.D., "Principles of Igneous and Metamorphic



Petrology”, Prentice Hall 2009

- Bucher, K. and Grapes, R., “Petrogenesis of Metamorphic Rocks”, Springer 2011
- Nichols, G.: Sedimentology and stratigraphy, 2nd Ed. WileyBlacwell 2009

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	-
CO2	3	2	3	2	2	3	1
CO3	2	1	3	2	2	3	2
CO4	2	2	2	3	2	3	1
CO5	2	1	2	2	2	3	2

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9, SDG 12,
CO2	SDG 4, SDG 9, SDG 13
CO3	SDG 4, SDG 9, SDG 13, SDG 15
CO4	SDG 7, SDG 9, SDG 12, SDG 13
CO5	SDG 6, SDG 9, SDG 12, SDG 13, SDG 15

GEO 443: Practical V- Igneous and Metamorphic Petrology, Paleontology and Stratigraphy

Credits:2

Course No:	Course Name: Practical V- Igneous and Metamorphic Petrology, Paleontology and Stratigraphy				Course Code: GEO 443		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L 0	T 0	P 4	Credits 2	Contact Hrs. per Week: 4 Total Hrs.: 60



Evaluation Criteria

- **Total Evaluation Mark: 100**
- **Mid-Term Examination (20%): 20**
- **End-Term Examination (60%): 60**
- **Continuous Internal Assessment (20%): 20**

Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: The main objective of this course is to introduce the students to different types of rocks in hand specimen, thin section as well as in the field and also to introduce them to analyse various types of petrological data and interpret them. This is also aimed to introduce the students to study morphological characters of different invertebrate and micro fossils and plant fossils and correlation of different sections.

Course Outcomes: After completion of the course the students will be able to:

CO1: identify igneous and metamorphic rocks in hand specimen and thin sections, and **explain** their textures, structures, and mineralogical composition using megascopic and microscopic observations.

CO2: apply CIPW norm calculations, ternary diagrams, and **demonstrate** plotting and presenting data-driven geological interpretations using appropriate graphical and analytical tools.

CO3: analyze morphological characters and modes of preservation of fossils, and **differentiate** invertebrate groups, trace fossils, microfossils, and significant Indian Gondwana and Paleogene flora, and develop and justify paleontological interpretations in a scientific framework.

CO4: evaluate sedimentary sequences, stratigraphic classifications, and correlations, and **assess** tectonic divisions, Gondwana provinces, and interpretations of sequence, magneto-, and seismic stratigraphy.

CO5: formulate integrated geological reports from petrological, paleontological, and stratigraphic data, and **design** and defend stratigraphic interpretations through structured scientific reporting.

Practicals- Igneous and Metamorphic Petrology:

Megascopic and microscopic study of different igneous (syenite, pitchstone granite, diorite, pegmatite, rhyolite, basalt, andesite, trachyte, norite, diorite, pyroxenite, lamprophyre) and metamorphic rocks (gneiss, schist, slate, phyllite, marble, quartzite, amphibolite; Calculation of CIPW norms; Ternary diagrams, Presenting major and trace element data for Igneous rocks

Practicals-Paleontology:

Study of modes of preservation of fossils; Study of morphological characters of important invertebrate fossils belonging to Brachiopoda, Bivalvia, Cephalopods, Arthropoda,



Gastropoda, Echinoidea, Foraminifera; Study of important trace fossils and microfossils; Study of important Indian Gondwana and Paleogene flora; Paleogeographic maps.

Practicals Stratigraphy:

Pre-Cambrian sedimentary basins of India, Phanerozoic sedimentary basins of India, tectonic divisions of India; Gondwana Provinces in India; Exercises on stratigraphic classification and correlation, sequence, magneto and seismic stratigraphic interpretations.

Field visits will be an integral part of this course, providing students with essential hands-on experience in geological investigations. These excursions will enable them to study rocks and fossils in their natural settings, enhancing their understanding of Igneous and Metamorphic, Petrology, as well as Paleontology and Stratigraphy. By observing field relationships, lithological variations, and fossil assemblages, students will learn to interpret Earth's geological history more effectively. The visits will bridge the gap between theoretical knowledge and practical application while fostering critical thinking and scientific inquiry. Overall, this experiential learning approach will strengthen their field skills and professional competence in geosciences.

Recommended Readings:

- A Practical Guide to Rock Microstructure - Ron H. Vernon, *Cambridge University Press*
- Atlas of Metamorphic Rocks and Their Textures - B. W. D. Yardley, W.S. MacKenzie and C. Guilford, *Prentice Hall*
- BGS Rock Classification Scheme Volume 1 Classification of igneous rocks -M. R. Gillespie and M. T. Styles, *British Geological Survey*
- Introduction to Metamorphic Textures and Microstructures - A. J. Barker, *Routledge*
- Laboratory Manual of Geology - A. K. Sen, *Modern Book Agency, Kolkata*
- Microtextures of Igneous and Metamorphic Rocks - J. P. Bard, *Springer*
- Petrography of Igneous and Metamorphic Rocks - Anthony R. Philpotts, *CBS Publishers*
- Practical Approach to Petrology - R. N. Hota, *CBS Publishers*
- Quantitative Textural Measurements in Igneous and Metamorphic Petrology - Michael D. Higgins, *Cambridge University Press*
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K.H. Brodie, *CRC Press*
- Historical Geological Lab Manual - Pamela J. W. Gore, *Wiley*
- Interpreting Earth History: A Manual in Historical Geology - Scott Ritter and Morris Petersen, *Waveland Press*
- Practical Approach to Petrology - R. N. Hota, *CBS Publishers*
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K. H. Brodie, *CRC Press*
- Paleontology: A Practical Manual - L. Mahesh Bilwa, *Studera Press*
- Practical Manual in Palaeontology - V. Manivannan and K. Subramani, *Vishal Publishing Co*

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined



Program Outcomes (POs).

The correlation is indicated as: 3 = High, 2 = Moderate, 1 = Low, – = no correlation

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	–	–	–
CO2	2	2	3	1	1	2	2
CO3	3	3	2	2	1	1	2
CO4	3	2	2	3	2	2	1
CO5	2	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcomes (COs)	Mapped SDGs
CO1	SDG 4, SDG 9, SDG 12
CO2	SDG 4, SDG 9, SDG 13
CO3	SDG 4, SDG 13, SDG 15
CO4	SDG 7, SDG 9, SDG 12, SDG 13
CO5	SDG 4, SDG 9, SDG 12, SDG 13



Elective/Optional/IDC Courses

GEO 408: Indian Knowledge System

Credits:2

Course No:	Course Name: Indian Knowledge System				Course Code: GEO 408		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: Bhārata has a very rich and versatile knowledge system and cultural heritage. The Bhāratīya knowledge system was developed during the Vedic period, the Saraswatī-Sindhu Civilization, the Middle ages and is being practiced till the conditions of modern times. In this basic course, a special attention is given to the historical prospective of ideas occurrence in the ancient society, and implication to the concept of material world, and religious, social, and cultural beliefs. On the closer examination religion, culture and science have appeared epistemological very rigidly connected in the Bhāratīya knowledge system. As such, this land has provided invaluable knowledge stuff to the society and the world in all the spheres of life; e.g. aeronautics, astronomy, mathematics, life science, medical science, architecture, polity, trade, art, music, dance, literature, and drama. Over the period, most of the works were either lost or confined to the libraries or personal possessions. However, some of the activities are still in practice of the masses unknowing the scientific and practical values. Given the nature of course and diversity of the learners' fields, the course is designed to provide a broad spectrum of the Bhāratīya knowledge system. The main objectives of this course are as follows:

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

CO1: identify major elements of the Saraswatī-Sindhu Civilization and **explain** the fundamentals of traditional knowledge systems and ancient education.

CO2: apply the principles of Bhāratīya arts, literature, and philosophy to interpret classical texts and **demonstrate** understanding of contributions by key scholars.



CO3: analyze ancient Bhāratīya scientific and mathematical concepts, including astronomy, calendrical systems, and Vedic mathematics, and **interpret** their relevance to modern scientific frameworks, and construct and present analytical comparisons using scientific reasoning.

CO4: assess engineering, technological, and architectural innovations of ancient India and **evaluate** their impact on societal development and sustainable practices, and defend their applicability through structured scientific and technical arguments.

CO5: design integrative models of ancient life, health, and environmental knowledge and **develop** interdisciplinary projects linking Bhāratīya knowledge systems with contemporary science, medicine, and ecology.

Course Content:

Unit-I: Genesis of the land, Antiquity of civilization, On the Trail of the Lost River, Discovery of the Saraswatī River, the Saraswatī-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy (6+3), Ancient Education System, the Takṣaśilā University, the Nālandā University, Alumni, Knowledge Export from Bhārata.

Unit-II: Arts, Literature, and Scholars (4 hours) Art, Music, and Dance, Naṭarāja– A Masterpiece of Bhāratīya Art, Literature, Life and works of Agastya, Lopāmudrā, Ghoṣā, Vālmīki, Patañjali, Vedavyāsa, Yājñavalkya, Gārgī, Maitreyī, Bodhāyana, Caraka, Suśruta, Jīvaka, Nāgārjuna, Kaṇāda, Patañjali, Kauṭīlya, Pāṇini, Thiruvalluvar, Āryabhaṭa, Varāhamihira, Ādi Śaṅkarācārya, Bhāskarācārya, Mādhavācārya.

Unit-III: Science, Astronomy, and Mathematics (4 hours) Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimāna: Aeronautics, Vedic Cosmology and Modern Concepts, Bhāratīya Kāla-gaṇanā, Kerala School for Mathematics and Astronomy, History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth, Archaeoastronomy; Concepts of Zero and Pi, Number System, Pythagoras Theorem, and Vedic Mathematics.

Unit-IV: Engineering, Technology, and Architecture (4 hours) Pre-Harappan and Sindhu Valley Civilization, Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet–Dwarkā.

Unit-V: Life, Environment, and Health (4 hours) Ethnic Studies, Life Science in Plants, Anatomy, Physiology, Agriculture, Ecology and Environment, Āyurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Medicine, Surgery, and Yoga, etc.

Recommended Readings:

- Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan,
- History of Science in India Volume-I, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of



Culture, Kolkata (2014).

- Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).
- Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012). 3. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010). Text books

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	2	1	2	1	1
CO3	1	2	3	3	2	2	3
CO4	1	1	3	2	3	2	3
CO5	–	1	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 11
CO2	SDG 4, SDG 11
CO3	SDG 4, SDG 9, SDG 13
CO4	SDG 9, SDG 11, SDG 12
CO5	SDG 3, SDG 4, SDG 12, SDG 13

GEO 409a: Natural Hazards

Credits:2

Course No:	Course Name: Natural Hazards				Course Code: GEO 409a		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							



Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: To develop an in-depth understanding of natural hazards—such as earthquakes, floods, landslides, volcanoes, and climate-induced events—and equip students with skills for disaster risk assessment, mitigation strategies, and management frameworks, with a focus on geological processes and spatial analysis.

Course Outcomes: After completing this course, students will be able to:

CO1: define natural hazards and **explain** their geological and geomorphological controls.

CO2: calculate earthquake ground motion parameters and **apply** hazard zoning techniques to assess earthquake-prone areas, and explain underlying concepts and present results through structured hazard reports.

CO3: analyze landslide and flood causes and **interpret** hazard maps using GIS and remote sensing data, and construct and communicate data-driven hazard assessments with scientific justification.

CO4: assess volcanic, coastal, and cyclone hazards and **evaluate** mitigation strategies and early warning systems, and defend hazard mitigation approaches based on geological principles and case studies.

CO5: design disaster risk reduction plans and **develop** field-based hazard assessment projects integrating geospatial tools and case studies.

Course Content:

Unit I: Introduction to Natural Hazards; Definition, classification, and concepts of hazard, vulnerability, risk, and disaster; Geological and geomorphological controls on natural hazards.

Unit II: Earthquake Hazards- Seismotectonics, fault systems, seismic waves, ground motion; Earthquake hazard zoning, liquefaction, structural damage assessment.

Unit III: Landslides and Slope Failures-Types, causes, and mechanics of landslides; Landslide hazard zonation using GIS and remote sensing; Floods and River Hazards; Causes of floods: meteorological, hydrological, and anthropogenic; Flood plain mapping and hydrological modelling

Unit IV: Volcanic and Coastal Hazards, Types of volcanoes, lava flow, ash fall, and associated risks, Tsunamis, cyclones, sea-level rise, and coastal erosion; Disaster Risk Reduction and Management; Early warning systems, mitigation planning, emergency response; National Disaster Management Authority (NDMA) guidelines; Community-based disaster risk reduction (CBDRR).



Unit V: Case Studies and Practical Applications- Indian and global disaster case studies (e.g., Uttarakhand floods, Bhuj earthquake); Use of GIS/remote sensing in hazard mapping; Field-based disaster risk assessment (if applicable).

Recommended Readings:

- Keller, E. A. & DeVecchio, D. E. – Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes, Routledge, 5th Edition, 2021 (Comprehensive foundation for all natural hazards)
- Smith, K. – Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge, 8th Edition, 2021 (Focuses on risk assessment and mitigation strategies)
- Bryant, E. – Natural Hazards, Cambridge University Press, 2nd Edition, 2005 (Fundamentals of hazard science with emphasis on climate and tectonics)
- Singh, R. B. (Ed.) – Natural Hazards and Disaster Management: Vulnerability and Mitigation, Rawat Publications, 2006 (Indian perspective and vulnerability mapping)
- NDMA Publications – Disaster Management Guidelines, National Disaster Management Authority, Government of India, (Available online; regularly updated for official policy framework)
- Sarkar, S. – Disaster Management, APH Publishing Corporation, 2007, (Indian context of disasters with case studies and mitigation).

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C01	3	2	1	1	2	–	1
C02	3	2	3	2	2	1	3
C03	3	2	3	3	2	2	3
C04	3	1	2	2	3	2	3
C05	–	1	3	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:



Course Outcome (CO)	Mapped SDGs
CO1	SDG 11, SDG 13
CO2	SDG 9, SDG 11
CO3	SDG 9, SDG 11, SDG 13
CO4	SDG 3, SDG 11, SDG 13
CO5	SDG 9, SDG 11, SDG 13

GEO 415b: Fundamentals in Gemology

Credits:2

Course No:	Course Name: Fundamentals in Gemology				Course Code: GEO 415b		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 2 Total Hrs.: 30
			2	0	0	2	
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The course aims to introduce students to the foundational concepts of gemstones. Introduce students to the foundations of gemology, including its scope, cultural significance, and role in the jewellery and gemstone industries. Familiarize students with the classification of gemstones, their physical and optical properties, and the criteria that determine their value. Provide knowledge of gemstone identification, testing, and differentiation between natural, synthetic, and imitation stones. Develop an understanding of the formation, mining, treatments, and market dynamics of colored stones. Equip students with applied skills in gemstone handling, customer interaction, ethical practices, and regulatory compliance within the gem and jewellery trade.

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

CO1: define fundamental gemological concepts and explain the historical, cultural, and industrial significance of gemstones, jewelry styles, and career pathways.



CO2: compare the physical properties of gemstones and **differentiate** natural, synthetic, and mounted gems based on hardness, density, cleavage, lustre, and crystallography, and explain the underlying mineralogical principles governing gemstone properties.

CO3: analyze light interactions and optical phenomena in gemstones and **interpret** results obtained using refractometers, microscopes, and other optical tools.

CO4: evaluate the geological formation, treatment, and commercial value of colored gemstones and **assess** market trends, synthetics, and imitation stones for professional decision-making.

CO5: examine the varieties, sources, and treatments of feldspar, quartz, and zircon, and **formulate** models for gemstone identification, classification, and commercial utilization, and construct and present professional gemological reports for practical applications.

Unit I: Introduction to Gemology: Definition and scope of gemology; Historical and cultural significance of gemstones; Overview of the gem industry and career pathways; Gemstone beauty, durability, rarity, portability; Natural vs synthetic vs imitation gems; Precious vs semi-precious: historical context and modern use; The Nature of Precious Metals; Jewellery styles; Translating features and Benefits to Sales; Regulation and Testing; Serving customers.

Unit II: Physical Properties of Gemstones; Hardness and the Mohs scale; Specific gravity and density; Durability, toughness; Cleavage, fracture, and tenacity; Surface lustre and transparency; Basics of crystallography (symmetry, systems, forms); Inclusions, twinning; Identifying rock, Parcels and mounted gems; Advanced Laboratory testing; Gem testing instruments

Unit III: Optical Properties of Gemstones: Light interaction: reflection, refraction, dispersion; Refractive index and birefringence; Allochromatic and idiochromatic gems Phenomena in gemstones: asterism, chatoyancy, play of color, iridescence, labradorescence, adularescence, aventurescence, color change, etc.; Introduction to optical tools: loupe, microscope, and refractometer

Unit IV: Introduction to Colored Stones; Colored stone Market; Plate tectonics, rock cycle, How Gems form, Mining and recovery, Primary and Secondary Deposits; Synthetics and Imitations; Treatments; Colored stone Market; Color, cut, clarity, carat weight and Gem Business

Unit V: Feldspar and its varieties, Quartz and chalcedony; quartz varieties, synthetics, chalcedony varieties and treatments and imitations; Zircon, its sources, market and treatments.

Suggested reading:

- Introduction to Gemology – H. Robert Webster
- Gems: Their Sources, Descriptions and Identification – Robert Webster
- Gemstones of the World – Walter Schumann
- Gem Identification Made Easy – Antoinette Matlins
- Gemstones: Understanding, Identifying, Buying – Keith Wallis



- Manual of Mineral Science – Cornelis Klein and Anthony Philpotts

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	3	3	2	1	2	1	1
CO3	1	2	3	3	2	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 8
CO2	SDG 9, SDG 12
CO3	SDG 4, SDG 9
CO4	SDG 8, SDG 9, SDG 12
CO5	SDG 4, SDG 9, SDG 12



Semester II

GEO 410: Elemental and Isotope Geochemistry

Credits:4

Course No:	Course Name: Elemental and Isotope Geochemistry				Course Code: GEO 410		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to equip postgraduate students with a comprehensive understanding of geochemical principles and isotope systems, enabling them to interpret Earth's complex processes through chemical and isotopic signatures. The course aims to provide students with theoretical knowledge and practical skills essential for analyzing the origin, evolution, and interactions of Earth materials. By integrating modern analytical techniques and real-world applications, the course prepares students to engage in advanced research and address challenges in geology, environmental science, and planetary studies.

Course Outcomes: Upon successful completion of this course the students will be able to:

CO1: describe the elemental composition of the Earth and **classify** elements based on their geochemical behavior, abundance, and partition coefficients.

CO2: explain radioactive decay processes and **apply** geochronological principles to isotopic dating and mass spectrometric data, and illustrate isotopic evolution trends and develop geochronological models.

CO3: analyze Rb–Sr and Sm–Nd isotopic datasets and **interpret** isochrons, CHUR models, and epsilon notation in petrogenetic contexts, and classify isotopic signatures and formulate petrogenetic evolution models.

CO4: evaluate U–Pb and Lu–Hf isotopic systems and **integrate** zircon-based isotopic evidence to constrain crustal evolution.



CO5: assess radiocarbon dating results and **synthesize** stable isotope signatures (C, N, O) to reconstruct environmental and geological processes.

Course Content:

Unit I: Fundamentals of Elemental Geochemistry; Introduction to geochemistry: Composition of the Earth: Core, mantle, crust; Geochemical classification of elements: Major, minor, trace, and rare earth elements (REEs); Goldschmidt's rules and classification (Lithophile, siderophile, chalcophile, atmophile); Partition coefficients.

Unit II: Nuclear Systematics: Discovery of Radioactivity, Internal structure of atoms, origin of elements, Decay modes of radionuclides: Beta decay, alpha decay, spontaneous and induced fission, Radioactive decay: law of radioactivity; Geochronometry: Growth of radiogenic daughters, Assumptions of dating, Isochrons, Principles of mass spectrometry, equation of motion of ions, isotope dilution.

Unit III: Rb-Sr method: Geochemistry of Rb and Sr, principles of dating, Rb-Sr isochrons; Sm-Nd method: Geochemistry of Sm and Nd, Principles and methodology, Isotope fractionation and CHUR, Model dates based on CHUR, epsilon notation, dating by Sm-Nd method, crustal residence time and application of Nd to petrogenesis.

Unit IV: The U-Pb method: Geochemistry of U and Th, Decay of U and Th isotopes, Principles and methodology, Wetherill concordia, Pb loss models, Refinements in analytical techniques, detrital geochronology; Commonly used accessory minerals for U-Pb geochronology; The Lu-Hf method: Geochemistry of Lu and Hf, Principles and methodology, CHUR and epsilon notation, Model Hf dates derived from CHUR, Hf isotopes in zircons.

Unit V: Radiocarbon (^{14}C) dating- Historical development, Principles, assumptions, calibration, reservoir age correction, disruption of natural radiocarbon abundance, measurement techniques (Conventional method and Accelerator Mass Spectrometer), and application of ^{14}C ; Stable isotopes: Carbon, Nitrogen and Oxygen, delta notation, and their variability in natural systems.

Recommended Readings:

- Krauskopf, K., and Bird, D.K., "Introduction to Geochemistry", McGraw-Hill Publ. 2005
- Holland, H.H. (Ed.), "A Treatise on Geochemistry" Prentice-Hall Publ. 2004
- McSween, H., Richardson, S.M., and Uhle, M.E., "Geochemistry: Pathways and Processes" Overseas Press 2006
- Schlesinger, W.H. and Bernhardt, E.S. "Biogeochemistry: An Analysis of Global Change", Associated Press, 3rd Ed. 2013
- Walther, J.V., "Essentials of Geochemistry", Jones and Bartlette Publ. 2008
- Killops, S.D. and Killops, V.J., "Introduction to Organic Geochemistry", Wiley Publ. 2010
- Claude, A. C., and Allegre, C. Sutcliffe "Isotope Geology", Cambridge University Press, 2009.



- Dickin, A.P. “Radiogenic Isotope Geology” Cambridge University Press, 2005.
- Faure, G. and Mensing, T. M., “Isotopes: Principles and Applications”, John Wiley, New York, 2004
- Rollinson, H., “Using geochemical data: evolution, presentation, interpretation” Pearson Education Limited, 1993
- Faure, G., “Principles of Isotope Geology”, John Wiley, 1986.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	3	2	2	3	2
CO3	1	3	3	3	2	3	2
CO4	1	1	2	3	3	2	2
CO5	1	1	2	2	3	2	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 12
CO2	SDG 4, SDG 9, SDG 13
CO3	SDG 9, SDG 12, SDG 13
CO4	SDG 9, SDG 13
CO5	SDG 12, SDG 13, SDG 15

GEO 411: Engineering Geology

Credits:2

Course No:	Course Name: Engineering Geology				Course Code: GEO 411		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30



Evaluation Criteria

- **Total Evaluation Mark: 100**
- **Mid-Term Examination (20%): 20**
- **End-Term Examination (60%): 60**
- **Continuous Internal Assessment (20%): 20**

Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: The primary objective of this course is to provide students with an in-depth understanding of geological principles and their practical applications in civil and geotechnical engineering. It aims to develop the ability to evaluate geotechnical conditions, analyze geological hazards, and assess the suitability of sites for infrastructure projects. The course also emphasizes integrating geological knowledge with engineering practices to ensure the safe, economical, and sustainable design and construction of engineering structures.

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

CO1: define engineering geology concepts and **explain** the role of geology in planning and execution of civil engineering projects.

CO2: calculate engineering properties of rocks and soils and **apply** them in site investigations and design of dams, tunnels, and foundations.

CO3: analyze structural features like folds, faults, and joints and **interpret** their influence on engineering constructions and project stability, and construct and present structural assessments with scientific justification for engineering applications.

CO4: assess landslide hazards and rock mass quality and **evaluate** seismic risks and environmental impacts for civil engineering projects, and defend hazard and risk assessments through structured technical reports and case studies.

CO5: design engineering geological maps and **develop** solutions for site selection, slope stabilization, and sustainable use of rocks and aggregates in construction.

Course Content:

Unit-I: Introduction to Engineering Geology; Definition, scope, and applications of engineering geology; Role of geology in planning and execution of engineering projects; Geological investigations in civil engineering: Surface and subsurface studies; Engineering properties of rocks and soils; Physical properties of construction materials: Stones, sand, aggregates; Structural features affecting engineering constructions: Folds, faults, joints, fractures, unconformities

Unit II: Engineering considerations in seismic zones: Seismic zoning of India; River valley projects; Dams – parts, types, criteria for site selection, forces acting on dams; Environmental Impacts of Dams & Reservoirs.

Unit III: Tunnels – parts, classification, ground conditions, geological considerations; Engineering Geological mapping for major civil projects



Unit IV: Engineering properties of rocks – laboratory and field tests; Concepts of rock mass classification – utilities – RMR and Q systems

Unit V: Landslides – concepts, classification, mapping techniques and analysis; Rock as construction materials and aggregate properties; Engineering Geological investigations related to highways, buildings, bridges and other structures

Recommended Readings:

- Anbalagan, R. Singh, B., Chakraborty, D. and Kohli, A. “A field Manual for Landslide investigations”. DST, Government of India, New Delhi, 2007
- Krynine, D.P., Judd, W.R. “Principles of Engineering Geology and Geotectonics” CBS Publications & Distributors, 2001
- Bell, F.G. “Fundamentals of Engineering Geology” Elsevier, 2007
- Singh, B. & Goel, R.K. “Rock mass classification: A practical approach in civil Engineering”, Elsevier, 1999
- Gokhale, K.V.G.K. “Principles of Engineering Geology” B.S. Publications, 2006

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	2	3	2	2	2	1
CO3	1	2	3	3	2	2	3
CO4	1	1	2	2	3	2	3
CO5	–	1	3	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 11
CO2	SDG 9, SDG 12
CO3	SDG 9, SDG 11
CO4	SDG 3, SDG 11, SDG 13
CO5	SDG 9, SDG 11, SDG 12



GEO 412: Ore Geology

Credits:2

Course No:	Course Name: Ore Geology				Course Code: Geo 412		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to introduce students to the principles of ore geology, with a focus on the origin, classification, distribution, and exploration of mineral deposits. The course covers the geological processes responsible for ore formation, types of ore deposits, mineral economics, and techniques used in mineral exploration and evaluation. It also aims to provide insights into the environmental and economic considerations associated with mineral resource development.

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

CO1: define fundamental ore-geological terms and **explain** the classification and processes of ore formation, including magmatic, hydrothermal, sedimentary, metamorphic, and supergene systems.

CO2: apply textural and structural criteria to ore minerals and **analyze** magmatic, magmatic-hydrothermal, and hydrothermal vein deposits in different tectonic settings, and explain underlying ore-forming principles and classification frameworks.

CO3: differentiate various placer and sediment-hosted ore deposits and **evaluate** the role of weathering and supergene processes in ore enrichment, and construct and present ore deposit models with scientific justification.

CO4: interpret the genesis of iron and uranium deposits in sedimentary environments and **assess** metamorphic ore systems such as skarn and greisen deposits, and defend genetic interpretations through structured geological reports and case studies.

CO5: correlate plate tectonic evolution with the distribution of ore deposits and **formulate** models for ore mineralization through geological time.

Course Content:

Unit I: Introduction to Ore Geology; Definition of ore, gangue, tenor, and grade; Classification of mineral deposits: Lindgren's and Bateman's classifications; Processes of ore formation: Magmatic, hydrothermal, sedimentary, metamorphic, supergene enrichment



Unit II: Textures and structures of ore and gangue minerals, Magmatic Deposits: Chromite deposits, Nickel Sulphide deposits, Kimberlites; Magmatic-hydrothermal deposits: Porphyritic copper deposits, porphyry molybdenum deposits, porphyry gold deposits, porphyry tin deposits, volcanic associated massive sulphide deposits (VMS), Hydrothermal Vein deposits and their classification

Unit III: Placers and Paleoplacers: Placer deposits, Eluvial, colluvial and fluvial deposits, beach sand deposits, Marine placers, paleo placers; Sediment hosted Copper lead Zinc deposits, sedimentary exhalative deposits, Mississippi Valley deposits; ore deposits formed by weathering: Bauxite deposits, laterite nickel deposits, Kaolin Deposits, Supergene manganese deposits, supergene sulphide enrichment

Unit IV: Iron ores of sedimentary affiliation: Classification of Iron ores, characteristics and genesis of iron formation, enriched hematite ore deposits; uranium ores of Sedimentary affiliation: Geochemistry of uranium and secondary environment; Unconformity type Uranium deposits; Sandstone hosted uranium deposits; Ores formed by Metamorphism: Skarn deposits; classification and genesis of skarn deposits, greisen deposits,

Unit V: Non-metallic deposits: Coal and petroleum; Plate tectonics and distribution of ore deposits, Ore mineralization through Geological time.

Recommended Readings:

- Evans, A.M., “Ore Geology and Industrial Minerals: An Introduction”, Blackwell Science, 3rd Ed. 1993
- Jensen, M. L and Bateman, A. Economic Mineral Deposits. John Wiley and sons
- Guilbert, J.M. and Charles F. P. Jr., “The Geology of Ore Deposits”, Waveland 1986
- Mookherjee, A., “Ore Genesis: A Holistic Approach”, Allied Publishers 1999
- Mishra, K.C., “Understanding Mineral Deposits”, Kluwer Academic publishers 2000
- Pohl, W.L., “Economic Geology”, Wiley Blackwell 2011

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	3	2	3	3	2	2	1
CO3	1	2	2	2	3	2	3
CO4	1	1	2	3	3	2	3
CO5	–	1	2	2	2	3	2



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 12
CO2	SDG 9, SDG 12
CO3	SDG 12, SDG 13, SDG 15
CO4	SDG 9, SDG 12, SDG 13
CO5	SDG 9, SDG 12, SDG 13

GEO 413: Practical-III: Elemental and Isotope Geochemistry, Engineering Geology, Ore Geology

Credits:2

Course No:	GEO Course Name: Practical-III: Elemental and Isotope Geochemistry, Engineering Geology, Ore Geology				Course Code: GEO 413		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L 0	T 0	P 0	Credits 2	Contact Hrs. per Week: 4 Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objectives the course are to study basic geochemical analyses and interpretation of major and trace element data; practically conduct geotechnical investigations and solving problems related to soil, rocks and engineering construction sites; recognise ore and industrial minerals in hand specimen and under microscope, identification and interpretation of various textures.

Course outcome: After completion of the course, the students would be able to:

CO1: calculate isotopic and radiogenic age parameters and **analyze** isotope geochemical datasets using isochrons, concordia diagrams, epsilon values, and kernel density estimates.

CO2: assess soil and rock properties for engineering suitability and **design** solutions for slope stability and site evaluation of major engineering structures.



CO3: identify ores, non-metallic minerals, and industrial rocks in hand specimens and **describe** their diagnostic physical properties and economic significance.

CO4: interpret isotopic patterns and **predict** geochemical trends in natural systems based on isotope ratios and age data.

CO5: evaluate isotopic datasets for geological interpretations and **predict** geochemical trends in natural systems based on isotope ratios and age data.

Practical- Elemental and Isotope Geochemistry:

Calculation of atomic weight of elements; Calculation and plotting of binding energy and neutron/proton ratios of various isotopes; Problems related to radioactive decay of nuclides.; Determination of, Rb-Sr, Sm-Nd, and U-Pb ages; Initial ratios and plotting of isochrons using Rb-Sr and Sm-Nd isotope data; Determination of Nd and Hf epsilon and their model ages; Plotting of Concordia diagram and determination of crystallisation and metamorphic ages; Kernel density estimates and applications

Practical-Engineering Geology:

Determination of specific gravity of soil; Determination of liquid limit, plastic limit, plasticity index, shrinkage limit, liquidity index and consistency index of soil; Determination of shear strength parameters of soil; Determination of strength of rocks; Determination of RQD and RMR; Problems related to stability of slopes; Study of site maps of important engineering structures such as dams and tunnels

Practical-Ore Geology:

Study of physical properties and identification of ores, non-metallic minerals, industrial rocks and minerals, gemstones and semi-precious minerals in hand specimens.

Field visits will be an integral component of this course, providing students with valuable hands-on exposure to real-world geological settings. These excursions will enhance their understanding of Elemental and Isotope Geochemistry, Ore Geology, and Engineering Geology through direct observation and practical investigations. Students will examine mineralization patterns, geochemical variations, and the engineering properties of rocks and soils in the field. By correlating theoretical concepts with real-time geological evidence, they will develop essential skills in sampling, data interpretation, and site assessment. This experiential approach will strengthen their technical competence and professional readiness in geosciences and geotechnical applications.

Recommended Readings:

- Using Geochemical Data: Evaluation, Presentation, Interpretation - H.G. Rollinson, Routledge
- Geotechnical Investigation Methods: A Field Guide for Geotechnical Engineers - Roy E. Hunt, CRC Press
- Introduction to Ore Microscopy - J. P. Shrivastava and Nishi Rani, Prentice Hall India
- Ore Microscopy and Ore Petrography - James R. Craig and David J. Vaughan, John Wiley & Sons
- The Ore Minerals Under the Microscope: An Optical Guide - Bernhard Pracejus,



Elsevier

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	3	3	2	2	2
CO2	2	2	3	2	3	3	2
CO3	3	3	2	1	2	1	1
CO4	2	2	3	3	2	2	2
CO5	2	2	3	3	3	2	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9, SDG 13
CO2	SDG 9, SDG 11
CO3	SDG 9, SDG 12
CO4	SDG 9, SDG 13
CO5	SDG 4, SDG 12, SDG 13

GEO 416: Geological Field Training-Mapping

Credits:2

Course No:	Course Name: Geological Field Training				Course Code: GEO 416		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week:
				0	2	2	Total Hrs.:
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							



Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objective: To equip M.Sc. Geology students with essential field work skills, hands-on training and discussion with eminent geologists and scientists. They will get practical hands-on training and field-based guidance.

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

CO1: identify key geological features in diverse terrains and **explain** their formation and significance in the regional geological context.

CO2: apply field mapping techniques and **construct** geological maps and cross-sections from observations made during field visits.

CO3: analyze lithological, structural, and stratigraphic data collected in the field and **interpret** spatial relationships between rock units and structures.

CO4: evaluate the reliability and significance of field observations and laboratory data, and **assess** geological hazards, resource potential, or site suitability.

CO5: formulate comprehensive field reports and **design** presentations or models that communicate geological interpretations effectively.

Course Content:

In this course, students shall carryout geological field work and mapping in diverse geological terrains of India, visit to geologically important areas and a visit to various laboratories of repute. Report on the fieldwork shall be submitted by the students individually or in groups, as decided by the teacher in-charge, before the commencement of semester examinations, which will be followed by viva-voce.

Suggested Reading

- Geological Field Techniques – by Angela L. Coe
- The Field Description of Igneous Rocks – by Dougal Jerram and Nick Petford
- The Field Description of Sedimentary Rocks – by Maurice E. Tucker
- The Field Description of Metamorphic Rocks – by Norman Fry
- Geological Fieldwork – by Steven Whitmeyer, David Mogk, and Eric Pyle
- Structural Geology – by Haakon Fossen
- Basic Geological Mapping – by John W. Barnes



PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	2	–	1
CO2	2	3	3	2	2	2	1
CO3	1	2	3	3	2	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13, SDG 15
CO2	SDG 4, SDG 9
CO3	SDG 9, SDG 12
CO4	SDG 11, SDG 12, SDG 13
CO5	SDG 4, SDG 9

GEO 418: Natural Hazard and Disaster Management

Credits:4

Course No:	Course Name: Natural Hazard and Disaster Management				Course Code: GEO 418		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							



Course Objectives: To develop an in-depth understanding of natural hazards—such as earthquakes, floods, landslides, volcanoes, and climate-induced events—and equip students with skills for disaster risk assessment, mitigation strategies, and management frameworks, with a focus on geological processes and spatial analysis.

Course Outcomes: After completing this course, students will be able to:

CO1: define natural hazards, vulnerability, risk, and disaster concepts and **explain** geological and geomorphological controls on hazards.

CO2: perform earthquake hazard assessment and **implement** structural damage evaluation and seismic zoning techniques.

CO3: analyze landslide and slope failure mechanisms and **interpret** flood hazards using GIS and hydrological modeling.

CO4: assess volcanic, coastal, and tsunami hazards and **evaluate** disaster risk reduction strategies, early warning systems, and mitigation plans.

CO5: design GIS-based hazard maps and **develop** community-based disaster management plans and emergency response strategies.

Course Content:

Unit-I: Introduction to Natural Hazards; Definition, classification, and concepts of hazard, vulnerability, risk, and disaster; Geological and geomorphological controls on natural hazards.

Unit-II: Earthquake Hazards- Seismotectonics, fault systems, seismic waves, ground motion; Earthquake hazard zoning, liquefaction, structural damage assessment.

Unit-III: Landslides and Slope Failures-Types, causes, and mechanics of landslides; Landslide hazard zonation using GIS and remote sensing; Floods and River Hazards; Causes of floods: meteorological, hydrological, and anthropogenic; Flood plain mapping and hydrological modelling

Unit-IV: Volcanic and Coastal Hazards, Types of volcanoes, lava flow, ash fall, and associated risks, Tsunamis, cyclones, sea-level rise, and coastal erosion; Disaster Risk Reduction and Management; Early warning systems, mitigation planning, emergency response; National Disaster Management Authority (NDMA) guidelines; Community-based disaster risk reduction (CBDRR).

Unit-V: Case Studies and Practical Applications- Indian and global disaster case studies (e.g., Uttarakhand floods, Bhuj earthquake); Use of GIS/remote sensing in hazard mapping; Field-based disaster risk assessment (if applicable)

Recommended Readings:

- **Keller, E. A. & DeVecchio, D. E.** – *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*, Routledge, 5th Edition, 2021 (*Comprehensive foundation for all natural hazards*)
- **Smith, K.** – *Environmental Hazards: Assessing Risk and Reducing Disaster*, Routledge, 8th Edition, 2021 (*Focuses on risk assessment and mitigation strategies*)



- **Bryant, E.** – *Natural Hazards*, Cambridge University Press, 2nd Edition, 2005 (*Fundamentals of hazard science with emphasis on climate and tectonics*)
- **Singh, R. B. (Ed.)** – *Natural Hazards and Disaster Management: Vulnerability and Mitigation*, Rawat Publications, 2006 (*Indian perspective and vulnerability mapping*)
- **NDMA Publications** – *Disaster Management Guidelines*, National Disaster Management Authority, Government of India, (*Available online; regularly updated for official policy framework*)
- **Sarkar, S.** – *Disaster Management*, APH Publishing Corporation, 2007, (*Indian context of disasters with case studies and mitigation*).

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	2	3	2	3	2	2
CO3	1	2	3	3	3	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	3	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 11, SDG 13
CO2	SDG 9, SDG 11
CO3	SDG 9, SDG 11, SDG 13
CO4	SDG 3, SDG 11, SDG 13
CO5	SDG 9, SDG 11, SDG 13



GEO 416: Sedimentary Petrology

Credits:2

Course No:	Course Name: Igneous, Metamorphic and Sedimentary Petrology				Course Code: GEO 416		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the origin, classification, and evolution of sedimentary rocks. The course aims to develop the ability to identify sedimentary rock types in hand sample and thin sections, understand the physical and chemical processes involved in their formation, and interpret their geological significance in the context of Earth's history. Emphasis is placed on mineralogical composition, textures, classification schemes, and field relations, as well as laboratory techniques used in petrographic analysis.

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

CO1: Define the fundamental concepts of sedimentology and **Explain** subaerial and submarine weathering processes, soil-forming processes, and sedimentary textures and structures.

CO2: Apply principles of sedimentary petrology to classify siliciclastic and carbonate rocks and **Differentiate** their compositional and diagenetic characteristics.

CO3: Analyze major, trace element, and isotopic data for provenance studies and **Interpret** the genesis of chemical, biochemical, and carbonaceous sedimentary rocks.

CO4: Evaluate continental and marginal marine depositional environments and **Demonstrate** their significance for stratigraphic correlation, basin evolution, resource evaluation, environmental management, and scientific reporting using sedimentological and stratigraphic evidence..



CO5: Design models of siliciclastic marine, carbonate, and evaporite environments and **Formulate** scientifically sound interpretations of their depositional evolution through structured research and professional reporting..

Course Content:

Unit I: Some fundamental concepts; Subaerial weathering processes; submarine weathering processes; soil forming processes; Sedimentary textures and structures;

Unit II: Composition, Classification and Diagenesis of sedimentary rocks, Siliclastic sedimentary rocks; Carbonate sedimentary rocks

Unit III: Major, trace elements and isotope; using trace element and isotopic data for provenance; Chemical/Biochemical and carbonaceous sedimentary rocks;

Unit IV: Depositional environments: Continental Environments; Marginal Marine environments;

Unit V: Siliclastic marine environments; carbonate and Evaporite environments

Recommended Readings:

- Rollinson, H., “Using geochemical data: evolution, presentation, interpretation” Pearson Education Limited 1993
- Nichols, G.: Sedimentology and stratigraphy, 2nd Ed. WileyBlackwell 2009
- Boggs, Sam (Jr.): Principles of Sedimentology and Stratigraphy, 4th Ed. Pearson/Prentice Hall. 2006
- Allen, P.A. and Allen, J.R.: Basin Analysis: Principles and applications. Blackwell publishing 2005
- Van Loon A.J.: Cyclic development of sedimentary basins. Elsevier. 2005
- Reading, H.G.: Sedimentary Environments and Facies. 6th Ed., Blackwell Scientific Publ., Oxford. 1996.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	–	–	–
CO2	2	3	2	1	–	–	–
CO3	2	1	3	2	2	1	1
CO4	2	2	2	3	3	2	2
CO5	1	–	2	2	2	3	3



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 12, SDG 15
CO2	SDG 4, SDG 9, SDG 12
CO3	SDG 4, SDG 9, SDG 13, SDG 15
CO4	SDG 4, SDG 13, SDG 14, SDG 15
CO5	SDG 4, SDG 9, SDG 12, SDG 13

GEO 441: Practical-IV: Elemental and Isotope Geochemistry, Ore Geology and Sedimentary Petrology

Credits:2

Course No:	Course Name: Practical-IV: Elemental and Isotope Geochemistry, Ore Geology and Sedimentary Petrology				Course Code: GEO 441		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 4
			0	0	0	2	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objective of this course is to introduce the students to different types of rocks in hand specimen, thin section as well as in the field and also to introduce them to analyse various types of petrological data and interpret them. This is also aimed to introduce the students to study morphological characters of different invertebrate and micro fossils and plant fossils and correlation of different sections.

Course Outcomes: After completion of the course the students will be able to:



CO1: List sedimentary rocks, textures, structures, and heavy minerals through megascopic and microscopic observations, and **Summarize** grain-size distributions, provenance signatures, and geochemical variations using graphical and analytical techniques.

CO2: Compute elemental and isotopic parameters, including radioactive decay ages and isotopic ratios, and **Illustrate** geochemical interpretations using isochrons, concordia diagrams, kernel density estimates, and related plots.

CO3: Examine the geotechnical properties of soils and rocks through laboratory testing and **Distinguish** slope stability conditions, rock mass quality, and engineering site characteristics using standard classification systems.

CO4: Assess the economic and industrial significance of ores, gemstones, and non-metallic minerals, and **Justify** their identification and utilization based on physical properties and geological occurrence.

CO5: Develop integrated geological models using sedimentological, geochemical, geotechnical, and ore data, and **Propose** scientifically sound solutions for exploration, resource management, and engineering applications.

Practicals- Sedimentary Petrology:

Megascopic and microscopic study of different sedimentary (shale, Breccia, limestone, conglomerate, sandstone, mudstone) rocks Ternary diagrams, Presenting major and trace element data for sedimentary rocks; Provenance estimate using geochemical data; Identification of heavy minerals under microscope; Grain-size analysis by sieving method; Plotting of size-distribution data as frequency and cumulative curves; sedimentary structures.

Practical- Elemental and Isotope Geochemistry:

Calculation of atomic weight of elements; Calculation and plotting of binding energy and neutron/proton ratios of various isotopes; Problems related to radioactive decay of nuclides.; Determination of, Rb-Sr, Sm-Nd, and U-Pb ages; Initial ratios and plotting of isochrons using Rb-Sr and Sm-Nd isotope data; Determination of Nd and Hf epsilon and their model ages; Plotting of Concordia diagram and determination of crystallisation and metamorphic ages; Kernel density estimates and applications

Practical-Engineering Geology:

Determination of specific gravity of soil; Determination of liquid limit, plastic limit, plasticity index, shrinkage limit, liquidity index and consistency index of soil; Determination of shear strength parameters of soil; Determination of strength of rocks; Determination of RQD and RMR; Problems related to stability of slopes; Study of site maps of important engineering structures such as dams and tunnels

Practical-Ore Geology:

Study of physical properties and identification of ores, non-metallic minerals, industrial rocks and minerals, gemstones and semi-precious minerals in hand specimens.



Field visits will be an integral component of this course, offering students valuable hands-on exposure to real-world geological settings. These excursions will enhance their understanding of Elemental and Isotope Geochemistry, Ore Geology, and Sedimentary Petrology through direct observation and sample-based learning. Students will examine mineralization patterns, geochemical variations, and sedimentary features in the field, enabling them to interpret geological processes more effectively. By correlating theoretical concepts with practical evidence, they will develop essential skills in field sampling, data interpretation, and analytical reasoning. This experiential approach will strengthen their technical competence and professional readiness in the geosciences.

Recommended Readings:

- Using Geochemical Data: Evaluation, Presentation, Interpretation - H.G. Rollinson, Routledge
- Geotechnical Investigation Methods: A Field Guide for Geotechnical Engineers - Roy E. Hunt, CRC Press
- Introduction to Ore Microscopy - J. P. Shrivastava and Nishi Rani, Prentice Hall India
- Ore Microscopy and Ore Petrography - James R. Craig and David J. Vaughan, John Wiley & Sons
- The Ore Minerals Under the Microscope: An Optical Guide - Bernhard Pracejus, Elsevier
- A Practical Guide to Rock Microstructure - Ron H. Vernon, *Cambridge University Press*
- Laboratory Manual of Geology - A. K. Sen, *Modern Book Agency, Kolkata*
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K.H. Brodie, *CRC Press*
- A Practical Approach to Sedimentology - Roy C. Lindholm, Springer
- Historical Geological Lab Manual - Pamela J. W. Gore, Wiley
- Interpreting Earth History: A Manual in Historical Geology - Scott Ritter and Morris Petersen, Waveland Press
- Practical Approach to Petrology - R. N. Hota, CBS Publishers
- Rocks and Minerals in Thin Section - W. S. MacKenzie, A. E. Adams and K. H. Brodie, CRC Press

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	1	2	–	1
CO2	2	2	3	2	2	1	1
CO3	1	2	3	2	3	1	1



COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO4	2	3	2	1	3	1	1
CO5	1	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9, SDG 12, SDG 15
CO2	SDG 4, SDG 9, SDG 13
CO3	SDG 1, SDG 11, SDG 13
CO4	SDG 4, SDG 8, SDG 9, SDG 12
CO5	SDG 4, SDG 9, SDG 12, SDG 11, SDG 13



Elective/Optional/IDC Courses

GEO 414: Indian Traditional Knowledge System

Credits:2

Course No:	Course Name: Indian Traditional Knowledge System				Course Code: GEO 414		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The course aims to introduce students to the foundational concepts and evolution of Indian traditional knowledge systems (ITKS) in the context of Earth and environmental sciences, explore ancient Indian contributions to geology-related fields such as hydrology, mining, metallurgy, natural resource management, and disaster understanding, build awareness of the scientific value of indigenous practices and their integration with modern geological research, encourage critical appreciation of how culture, religion, environment, and science co-evolved in Bhāratīya civilization, foster innovation by blending traditional knowledge with modern earth science applications.

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

CO1: define Indian traditional knowledge systems and **explain** the interconnections among science, philosophy, religion, and ecology in ancient texts.

CO2: illustrate the Panchamahabhūta theory and **apply** traditional cosmology concepts to interpret Earth system phenomena.

CO3: analyze ancient mining, metallurgy, and water management practices and **interpret** their relevance to modern earth sciences.

CO4: assess sacred geography and environmental ethics in Indian philosophy and **evaluate** traditional disaster knowledge and resilience strategies.

CO5: design integrated models combining ITKS with modern science and **develop** innovative applications for watershed management, seismic risk assessment, and sustainable resource use.

Course Content:



Unit-I: Introduction to Bhāratīya Knowledge Systems, Definition, scope, and significance of Indian traditional knowledge, Sources: Vedas, Purāṇas, Āgamas, and other ancient texts, Interconnection of science, philosophy, religion, and ecology,

Unit-II: Concepts of Bhūmi (Earth), Jal (Water), Vāyu (Air), Agni (Fire), and Ākāśa (Space), Panchamahabhūta theory and its relevance in earth sciences, Traditional cosmology and time cycles (Yugas, Kalpas).

Unit-III: Geology and Mineral Sciences in Ancient India, Ancient mining, metallurgy, and rock classification, Knowledge of soil types, gemstone usage, and metal extraction, Archaeological and literary evidence of resource exploitation, Water Management and Environmental Ethics, Ancient water harvesting systems: step wells, tanks, and canals.

Unit IV: Sacred geography: rivers, mountains, and pilgrimage ecosystems, Environmental ethics in Indian philosophy (e.g., concept of *ṛta* and *dharma*), Disaster Knowledge and Earth System Understanding, Traditional observations of earthquakes, droughts, and floods, Earthquake forecasting myths and oral history, Indigenous coping and resilience systems.

Unit V: Integrating ITKS with Modern Science, Critical assessment of the scientific basis of ITKS, Opportunities for research and innovation, Case studies: watershed management, seismic risk zones.

Recommended Readings:

- M.K. Jain – Indian Ethos and Wisdom for Management, New Age International Publishers, New Delhi, 2022.
- Kapil Kapoor (Ed.) – Encyclopedia of Hinduism (Relevant Volumes on Science and Nature), Rupa & Co., 2012.
- Debal Deb – Beyond Development: Reclaiming Indigenous Futures
- Michel Danino – The Lost River: On the Trail of the Sarasvati, Penguin India, 2010.
- Subhash Kak – The Astronomical Code of the Ṛigveda, Aditya Prakashan, 2016 (3rd edition).
- D. P. Agrawal – Ancient Metal Technology and Archaeology of South Asia, Aryan Books International, New Delhi, 2000.
- Nanditha Krishna – Sacred Plants of India, Penguin Books India, 2014.
- Ministry of Education (GoI) – UGC Guidelines on Indian Knowledge System (IKS), 2022.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO2	2	3	2	1	2	1	1
CO3	1	2	3	3	2	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13, SDG 15
CO2	SDG 4, SDG 13
CO3	SDG 6, SDG 9, SDG 12
CO4	SDG 11, SDG 13, SDG 15
CO5	SDG 6, SDG 9, SDG 12, SDG 13

GEO 415a: Geo-Environmental Impacts of Mining with Special reference to the Himalayan Region

Credits:2

Course No:	Course Name: Geo-Environmental Impacts of Mining with Special Reference to the Himalayan Region				Course Code: Geo 415a		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: II	L 2	T 0	P 0	Credits 2	Contact Hrs. per Week: 2 Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							



Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: The primary objective of this course is to develop a comprehensive understanding of the geological, geomorphological, and tectonic framework of the Himalayan region and its implications for mining activities; examine the environmental, hydrological, ecological, and socio-economic impacts of mining in fragile mountain ecosystems; analyze mining-induced hazards such as landslides, slope instability, debris flows, river sedimentation, and groundwater contamination in tectonically active terrains; integrate geospatial technologies (Remote Sensing and GIS) for monitoring and assessment of mining-related environmental degradation; evaluate national environmental legislation, sustainable mining policies, and restoration strategies relevant to Himalayan states; promote interdisciplinary approaches linking geology, environmental science, disaster management, engineering geology, and public policy; develop capacity for designing mitigation, reclamation, and eco-restoration plans suited to high-relief and ecologically sensitive regions.

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

CO1: Describe the lithotectonic divisions and tectonic evolution of the Himalaya and **explain** associated structural features, seismicity, and mineral resources..

CO2: Apply appropriate mining techniques in mountainous regions and **distinguish** between surface and underground mining practices under varying terrain conditions.

CO3: Analyze the environmental impacts of mining on slope stability, hydrology, and ecosystems and **interpret** their role in disaster risk amplification.

CO4: Evaluate geospatial data for mining impact assessment and **assess** hazard zonation using GIS and remote sensing techniques..

CO5: Formulate sustainable mining strategies and **develop** frameworks for environmental governance, community participation, and climate resilience.

Unit I: Geological and Tectonic Framework of the Himalaya- evolution of the Himalayan orogeny; Lithotectonic divisions: Tethyan, Greater, Lesser, and Siwalik Himalaya; Structural discontinuities (Main Central Thrust, Main Boundary Thrust, Main Frontal Thrust); Seismicity and neotectonics; Mineral resources of the Himalayan region (Sand, Slate, limestone, , gypsum, etc.)

Unit II: Mining Practices in Mountainous Terrains - Surface vs. underground mining in high-relief areas; Quarrying in limestone belts of Uttarakhand and Himachal Pradesh; Infrastructure challenges in steep terrains; Overburden disposal and waste management; Case studies from Himalayan mining regions



Unit III: Geo-environmental Impacts- Slope instability and landslides induced by mining; Soil erosion, debris flow, and sedimentation in river systems; Hydrological disruption: springs, groundwater recharge, and aquifer damage; Acid mine drainage and heavy metal contamination; Impacts on biodiversity and forest ecosystems; Mining and disaster risk amplification

Unit IV: Geospatial Monitoring and Assessment - Remote sensing applications in mining impact assessment; Change detection analysis using satellite imagery; DEM-based slope and drainage analysis; GIS-based hazard zonation mapping; Monitoring reclamation and land-use changes.

Unit V: Environmental Governance and Sustainability - Environmental Impact Assessment (EIA) process; Mine closure planning and reclamation strategies; National Mineral Policy and environmental regulations; Sustainable mining frameworks; Community participation and socio-economic considerations; Climate change implications for Himalayan mining regions.

Suggested reading:

- **Environmental Impact of Mining** by Ravi Jain, Lloyd Urban, and Gary Stacey.
- **Introduction to Mining Engineering** by H. L. Hartman and J. M. Mutmanský.
- **Environmental Geology** by Edward A. Keller.
- **Engineering and Environmental Geology** edited by Paul Marinos, V. G. Marinos, and T. H. S. Tsiambaos.
- **Geomorphology of the Himalaya** by H. S. Sharma.
- Valdiya, K. S. (2010). **The Making of India: Geodynamic Evolution**.
- Singh, R. B., and Haigh, M. (Eds.). **Environmental Change and Biodiversity in the Himalaya**.
- Central Pollution Control Board (CPCB) Guidelines on Mine Environment Management.
- Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India – EIA Notification documents.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	2	–	1
CO2	2	3	3	2	2	2	1
CO3	1	2	3	3	3	2	2



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO4	1	2	3	2	3	2	2
CO5	–	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 9, SDG 13, SDG 15
CO2	SDG 9, SDG 12
CO3	SDG 11, SDG 13, SDG 15
CO4	SDG 9, SDG 11, SDG 13
CO5	SDG 11, SDG 12, SDG 13, SDG 15

GEO 426: Gemstones-Diamonds (IDC)

Credits:2

Course No:	Course Name: Gemstones-Diamonds (IDC)				Course Code: GEO 426		
Batch: 2025-2026	Programme: M.Sc. Geology	Semester: I	L	T	P	Credits	Contact Hrs. per Week: 2
			0	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: This course aims to provide comprehensive knowledge of diamonds by exploring their origin, geological occurrence, physical and optical properties, and global economic significance. It seeks to develop an understanding of the Four C's—cut, color, clarity, and carat weight—along with the principles of diamond formation, exploration, and mining from primary and secondary deposits. The course equips students with practical insights into diamond cutting, polishing, grading, and valuation using standardized gemological techniques. It also fosters the ability to distinguish natural diamonds from simulants, synthetics, and treated stones while promoting awareness of modern markets, certification systems, and ethical trade



practices. Aligned with NEP 2020, the course enhances analytical, technical, and research skills, preparing students for professional careers in gemology and geosciences with a strong commitment to sustainability and responsible resource utilization.

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

CO1: Define the factors influencing diamond value, including the Four C's and historical evolution of the diamond industry, and **explain** the processes of diamond formation and their journey to the Earth's surface.

CO2: Apply systematic techniques for diamond exploration and mining in primary and secondary deposits, and **analyze** the global distribution and sources of diamonds.

CO3: Identify the atomic structure, optical properties, and grading parameters of diamonds, and **differentiate** among diamond shapes, light performance characteristics, and qualities of rough and polished stones.

CO4: Assess diamond cutting processes and grading standards for quality determination, and **defend** gemological reports on clarity and color based on professional and ethical principles.

CO5: Design proportion-based grading frameworks for evaluating diamond quality, and **formulate** strategies to distinguish and manage diamond simulants, synthetics, and treatments in accordance with industry standards.

Course Content:

Unit I: Diamonds and Value: Diamond value and the four C's; Why diamonds are forever (hardness, toughness and stability); Birth of Modern Diamond Industry, History of Rough Diamond Distribution; Modern Diamond Markets and cutting centers; How Diamonds Form and reach the surface

Unit II: Exploration for Diamonds: Primary and Secondary Deposits, Step-by-Step Guide for Finding Diamonds; Diamond Mining: Mining Primary and secondary deposits, World diamond sources

Unit III: The diamond Crystal: Atomic structure of diamonds, diamond crystal cutting, value, shapes; evaluating rough diamonds; Diamonds and light: transmission, reflection, refraction and Dispersion; Light and diamonds' appearance: Brightness, Fire, Scintillation; Grading round brilliant

Unit IV: The Evolution of Diamond Cutting: Cutting process (cleaving, sawing, bruting and polishing); Finding and identifying clarity characteristics: Type of clarity characteristics (inclusions, blemishes and others); Grading clarity and color in diamonds

Unit V: Grading Proportions in diamonds (Table, crown, girdle, Pavilion and culet); Evaluating finish, Recutting and repolishing diamonds; Diamond simulants, synthetics and treatments.

Suggested reading:

- Introduction to Gemology – H. Robert Webster



- Gems: Their Sources, Descriptions and Identification – Robert Webster
- Gemstones of the World – Walter Schumann
- Gem Identification Made Easy – Antoinette Matlins
- Gemstones: Understanding, Identifying, Buying – Keith Wallis
- Manual of Mineral Science – Cornelis Klein and Anthony Philpotts

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	–	2	–	2	–
CO2	2	2	3	1	2	1	–
CO3	2	3	2	–	1	–	–
CO4	1	2	2	–	3	–	3
CO5	1	1	2	–	3	2	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 12
CO2	SDG 8, SDG 9, SDG 12
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 12, SDG 16
CO5	SDG 4, SDG 9, SDG 12



Semester III

GEO 502: Literature Review and Research Proposal-Theory

Credits:4

Course No:	Course Name: Literature Review and Research Proposal-Theory				Course Code: GEO 502		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: In essence, a literature review is a critical and essential component of research that not only informs the research process but also helps shape the research itself. It ensures that new research is built upon a solid foundation of prior knowledge and contributes meaningfully to the academic or scientific community. Literature review will suggest whether the any work has previously been done on the topic and aids in avoiding avoids replication.

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

CO1: identify relevant literature in their area of specialization and **explain** key concepts, theories, and methodologies reported in prior research.

CO2: apply appropriate research methods and experimental techniques to their topic and **illustrate** the rationale for selecting specific approaches or datasets.

CO3: analyze collected data using quantitative and qualitative tools and **differentiate** patterns, trends, and anomalies in the results.

CO4: evaluate the significance of their findings in the context of existing literature and **assess** the strengths, limitations, and reliability of their study.

CO5: formulate conclusions and recommendations based on their research outcomes and **design** innovative solutions, models, or frameworks in their field of specialization.



Course Content:

Unit I: Foundations of Research and Problem Identification: Nature and scope of scientific research; Types of research (basic, applied, interdisciplinary); Research ethics and integrity; Identification and formulation of research problems; Defining research objectives and questions; Framing hypotheses; Role of specialization in selecting research themes.

Unit II: Literature Survey and Information Sources: Types of scientific literature: primary, secondary, and tertiary sources; Use of libraries, journals, e-resources, and databases (Scopus, Web of Science, Google Scholar, etc.); Techniques for effective literature search; Keywords and search strategies; Review of classical and recent literature in the chosen specialization.

Unit III: Critical Review and Synthesis of Literature: Methods of reading scientific papers; Critical evaluation of research articles; Identifying research gaps and trends; Comparative analysis of previous studies; Literature mapping and thematic organization; Referencing styles and citation management tools; Avoiding plagiarism.

Unit IV: Research Design and Methodology: Components of research design; Qualitative and quantitative approaches; Selection of appropriate methods and techniques; Sampling strategies; Data collection methods (field, laboratory, secondary data); Basic concepts of data analysis and interpretation; Limitations and scope of proposed methods.

Unit V: Research Proposal Writing and Presentation: Structure of a research proposal: title, abstract, introduction, literature review, objectives, methodology, expected outcomes, timeline, and references; Writing techniques and scientific style; Preparation of charts, figures, and tables; Proposal presentation skills; Peer review and revision of proposals.

Recommended Readings:

- Jesson, J. K., & Lacey, F. M. (2006). How to do (or not to do) a critical literature review. *Pharmacy education*, 6(2), 139-148.
- Khan, S.K., Popay, J., & Kleijnen, J. (2001). Undertaking systematic reviews on research and effectiveness. New York: CRD. www.york.ac.uk/inst/crd/report4.htm.
- Li Wan Po, A. (1997). A practical guide to undertaking a systematic review. *Pharmaceutical Journal*, 258, 518-520.
- The Literature Review: A Step-by-Step Guide for Students SECOND EDITION by Diana Ridley, Sheffield University, UK
- Khan, K.S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five steps to conducting a systematic review. *Journal of the Royal Society of Medicine*, 96 (3), 118-121.
- The Literature Review by Machi Lawrence A. SAGE Publications Inc. ISBN: 9781506336244 Pages: 192

PO-CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	1
CO2	2	2	3	2	2	2	2
CO3	1	2	3	3	2	2	2
CO4	1	1	2	3	3	2	2
CO5	—	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 12
CO5	SDG 4, SDG 9, SDG 13

GEO 503: Literature Review and Research Proposal-Project

Credits:4

Course No:	Course Name: Literature Review and Research Proposal-Project				Course Code: GEO 503		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 4
			0	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: In essence, a literature review is a critical and essential component of research that not only informs the research process but also helps shape the research itself. It ensures that new research is built upon a solid foundation of prior knowledge and contributes



meaningfully to the academic or scientific community. Literature review will suggest whether the any work has previously been done on the topic and aids in avoiding avoids replication.

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

CO1: Identify relevant research problems in the area of specialization and **explain** key concepts derived from scientific literature.

CO2: Apply appropriate methodologies to research questions and **differentiate** between various theoretical and analytical approaches.

CO3: Examine published literature critically and **organize** information to establish coherent research frameworks, and construct and present synthesized literature reviews with logical scientific arguments.

CO4: Assess the validity of research findings and **justify** the selection of methods and interpretations in the dissertation, and defend research decisions through structured scientific writing and presentations.

CO5: Design a research study based on identified gaps and **compose** a report presenting original analysis and conclusions.

Course Content:

This course is designed to develop advanced research competence in students through an in-depth literature review and the **preparation of a report** in the selected area of specialization. The readings and research focus will be aligned with advanced specialized courses undertaken by the student. The course begins with the identification of a research problem within the selected specialization, followed by a comprehensive review of relevant national and international literature. Emphasis will be placed on critical analysis, synthesis, and interpretation of existing research, enabling students to identify knowledge gaps, research trends, and unresolved scientific questions, and subsequently, the students will develop a research proposal. The entire process is intended to foster independent research skills, scientific writing ability, critical thinking, and domain-specific expertise aligned with the chosen specialization.

Recommended Readings:

- The course readings will be determined based on the selected area of specialization, drawing from current and foundational literature to support in-depth study and the development of the dissertation.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	2	1	1



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO2	2	2	3	2	2	2	1
CO3	1	3	2	3	2	2	3
CO4	1	1	2	3	3	2	3
CO5	—	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 12
CO5	SDG 4, SDG 9, SDG 13

GEO 519: Research Methodology

Credits:4

Course No:	Course Name: Research Methodology-Theory				Course Code: GEO 519		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none"> ➤ Total Evaluation Mark: 200 ➤ Mid-Term Examination (20%): 40 ➤ End-Term Examination (60%): 120 ➤ Continuous Internal Assessment (20%): 40 							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objective of the course is to introduce the students to the fundamentals of scientific research including identification of research problem, research planning, research design, use of statistical tools and computer application in geoscientific research.

Course Outcome: Upon successful completion of this course, the student will be able to:



CO1: define fundamental concepts of scientific research and **explain** the process of problem identification, research design, and significance of research in geology.

CO2: apply statistical and mathematical methods, including PCA, Markov chains, and cluster analysis, to process geological data, and **demonstrate** trend surface analysis and tests of significance.

CO3: analyze research literature and datasets to develop coherent research proposals, and **differentiate** between abstracts, summaries, and full scientific reports or papers.

CO4: evaluate the effectiveness of different operating systems and application software for geological research, and **assess** open-source and specialized geoscience software for data processing and visualization.

CO5: formulate ethical research practices, including authorship issues, and **design** strategies for responsible publication, open-access selection, and metric evaluation.

Course Content:

Unit I: Fundamentals of scientific research; identification and definition of research problem; basic concepts of research design; review of literature; significance and status of research in geology, Basic information of a research publication. Types of research publications specifically the original research articles, reviews and book chapter. Various Publishers and journals related to geology.

Unit II: Basic information about a research proposal, Problem/Challenges/ gaps identification for research proposal. Different steps in writing a research proposal such as defining the research questions, defining of objectives, identifying the difference between research question and objective. Importance of research methodology in a proposal.

Unit III: Methods of data collection in geology; processing, preparation and analysis of data in geology; data display and interpretation; basic mathematical and statistical methods (mean, median, mode, standard deviation); principal component analysis (PCA).

Unit IV: Developing a research proposal in geology; writing research report and scientific paper; peer review process for journals; writing a thesis/dissertation; abstract and summary writing, softwares in geology; open-source software.

Unit V: Introduction to philosophy and ethics, Ethics concerning science and research, intellectual honesty and research integrity, Scientific misconduct, duplicate and overlapping publications, selective reporting and misinterpretation of data, conflict of interest, authorship and contribution, predatory publishers, open access publication, journal finders and journals, research metrics, impact factor of journal and metrics, h-index etc.

Recommended Readings:

- Yadav, S.K. research and Publication Ethics. Ane Books Private Limited
- Basu, Chakrabarty and Sinha. Research and Publication Ethics. 2021. Concept Publishing Company Pvt. Ltd.; First Edition.
- Verma, V and Kapoor. Research and publication ethics: core concepts and principles. Bharti Publications; First Edition, 2023



- Jesson, J. K., & Lacey, F. M. (2006). How to do (or not to do) a critical literature review. *Pharmacy education*, 6(2), 139-148.
- Khan, S.K., Popay, J., & Kleijnen, J. (2001). Undertaking systematic reviews on research and effectiveness. New York: CRD. www.york.ac.uk/inst/crd/report4.htm.
- Li Wan Po, A. (1997). A practical guide to undertaking a systematic review. *Pharmaceutical Journal*, 258, 518-520.
The Literature Review: A Step-by-Step Guide for Students SECOND EDITION by Diana Ridley, Sheffield University, UK
- Khan, K.S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five steps to conducting a systematic review. *Journal of the Royal Society of Medicine*, 96 (3), 118-121.
- The Literature Review by Machi Lawrence A. SAGE Publications Inc. ISBN: 9781506336244 Pages: 192

PO-CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: 3 = High, 2 = Moderate, 1 = Low, – = no correlation

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	1	1
CO2	2	2	3	2	2	3	2
CO3	2	3	2	3	2	2	2
CO4	1	2	2	2	3	2	2
CO5	1	1	2	2	3	2	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 9
CO5	SDG 4, SDG 12, SDG 16

GEO 516: Fundamentals of Climate and Ocean

Credits: 2



Course No:	Course Name: Fundamentals of Climate and Ocean				Course Code: GEO 516		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 2
			2	0	0	2	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: To provide M.Sc. Geology students with a comprehensive understanding of atmospheric and oceanic systems, their interactions, and their roles in shaping Earth's climate and geological processes. The course emphasizes physical principles, global circulation patterns, paleoclimate indicators, and the ocean's role in Earth system science.

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

CO1: identify the components of the atmosphere and **describe** the processes governing insolation, heat budget, and atmospheric circulation.

CO2: interpret the dynamics of weather systems such as monsoons and cyclones and **illustrate** general atmospheric circulation patterns.

CO3: apply climate classification systems and **distinguish** between different theories of climate change.

CO4: analyze the structure of ocean basins and **examine** the physical and chemical properties of ocean water.

CO5: evaluate the factors controlling ocean circulation and **formulate** explanations for oceanic phenomena such as ENSO and thermohaline circulation and construct and present scientific interpretations through reports, models, and visual representations.

Course Content

Unit I: Basics of Climate and Atmosphere: Structure and composition of the atmosphere, Insolation, heat budget, albedo, and temperature distribution, Atmospheric pressure systems and wind circulation.

Unit II: Weather Systems and Climate Classification- Monsoons, cyclones, anticyclones, and jet streams, General atmospheric circulation

Unit III: Köppen and Thornthwaite climate classification systems, Theories of Climate change (displacement of continents, change in atmospheric composition, geographical and change in solar radiation)



Unit IV: Oceanography definition and scope; Physical Oceanography and Processes- Origin and structure of ocean basins, Physical and Chemical characteristics of ocean water (Temperature, salinity, density and dissolved gases in sea water),

Unit V: Introduction of Water mass and Indian Ocean water mass, Basics of Ocean circulation, factors controlling ocean circulation (Vertical and horizontal) and Oceanic currents: surface and deep-water circulation (thermohaline), El Niño Southern Oscillation (ENSO), North Atlantic Oscillation (NAO)

Recommended Readings:

- Critchfield, H. J. – General Climatology, Prentice Hall of India, 4th Edition, 1987 (Classic climatology text, especially for tropical climates and monsoon systems)
- Barry, R. G. & Chorley, R. J. – Atmosphere, Weather and Climate
- Routledge, 9th Edition, 2009 (Modern, comprehensive overview of atmospheric science and climate systems)
- Tomczak, M. & Godfrey, J. S. – Regional Oceanography: An Introduction, Daya Publishing House, 2003 (Indian Reprint), (Excellent introductory text on physical oceanography, with regional examples)
- Gross, M. Grant – Oceanography: A View of the Earth, Pearson Education, 8th Edition, 2006, (Covers Ocean structure, processes, and marine geology)
- Emery, K. O. & Uchupi, E. – The Geology of the Atlantic Ocean, Springer, 1972, (For marine geological perspectives and plate tectonic evolution of oceans)
- Garrison, T. – Essentials of Oceanography, Cengage Learning, 8th Edition, 2015, (Concise and illustrative overview for students new to ocean science)
- IPCC Reports (Intergovernmental Panel on Climate Change)
- Available freely at www.ipcc.ch (Essential for current global climate change data and assessments)
- Lal, D. S. Climatology, Sharda Pustak Bhawan
- Singh, S. Climatology, Pravalika Publications
- Lal, D. S. Climatology and Oceanography, Sharda Pustak Bhawan

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	2	2	2	1	1
CO3	2	3	3	2	2	2	2
CO4	1	2	3	3	2	2	2
CO5	1	1	2	2	3	3	3



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13
CO2	SDG 11, SDG 13
CO3	SDG 4, SDG 13
CO4	SDG 13, SDG 14
CO5	SDG 4, SDG 13, SDG 14

GEO 517: Gemology

Credits:2

Course No:	Course Name: Gemology				Course Code: GEO 517		
Batch:	Programme:	Semester:	L	T	P	Credits	Contact Hrs.
2026-2027	M.Sc.	III					per Week: 2
	Geology		4	0	0	4	Total Hrs.: 30
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective:

This course aims to: Introduce students to the foundations of gemstones, including its scope, cultural significance, and role in the jewellery and gemstone industries. Familiarize students with the classification of gemstones, their physical and optical properties, and the criteria that determine their value. Provide knowledge of gemstone identification, testing, and differentiation between natural, synthetic, and imitation stones. Develop an understanding of the formation, mining, treatments, and market dynamics of colored stones, with emphasis on key gemstones such as ruby and sapphire. Equip students with applied skills in gemstone handling, customer interaction, ethical practices, and regulatory compliance within the gem and jewellery trade.

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

CO1: Define the scope, physical and optical properties, and crystallographic aspects of gemstones, and **explain** the principles and applications of gem testing instruments.



CO2: Apply gemological criteria to identify colored gemstones, their deposits, imitations, and treatments, and **analyze** the classification, sources, and characteristics of major gem families such as emerald, ruby, sapphire, garnet, feldspar, zircon, and beryl.

CO3: Evaluate the quality and value of diamonds based on the Four C's, crystallography, and optical properties, and **illustrate** the processes of diamond formation, grading, and light performance.

CO4: Differentiate diamond cutting techniques and clarity characteristics, and **develop** scientific models linking clarity, color, and crystallographic features with diamond genesis and grading standards.

CO5: Design systematic approaches for grading diamond proportions and identifying quartz varieties, and **formulate** strategies to distinguish natural gemstones from simulants, synthetics, and treated stones.

Course Content

Unit I: Introduction to Gemology: Definition and scope of gemology; Gemstone beauty, durability, rarity, portability; Physical Properties of Gemstones; Hardness and the Mohs scale; Specific gravity and density; Durability, toughness; Cleavage, fracture, and tenacity; Surface lustre and transparency; Basics of crystallography; Gem testing instruments, Optical Properties of Gemstones

Unit II: Introduction to Colored Stones; Primary and Secondary Deposits; imitation and treatments; The Big 3 (emerald, ruby and sapphire); Garnet and their classification, their sources; Feldspar and its varieties, zircon, beryl, its varieties and treatments.

Unit III: Diamonds and Value: Diamond value and the four C's; Why diamonds are forever (hardness, toughness and stability); How Diamonds Form and reach the surface; The diamond Crystal: Atomic structure of diamonds, diamond crystal cutting, value, shapes; evaluating rough diamonds; Diamonds and light: transmission, reflection, refraction and Dispersion; Light and diamonds' appearance: Brightness, Fire, Scintillation; Grading round brilliant

Unit IV: The Evolution of Diamond Cutting: Cutting process (cleaving, sawing, bruting and polishing); Finding and identifying clarity characteristics: Type of clarity characteristics (inclusions, blemishes and others); Grading clarity and color in diamonds

Unit V: Imitation and synthetics of the big 3, qualities, formation and treatments, quartz varieties, their treatments and imitations; Grading Proportions in diamonds (Table, crown, girdle, Pavilion and culet); Evaluating finish, Recutting and repolishing diamonds; Diamond simulants, synthetics and treatments.

Recommended Readings:

- Cornelius S. Hurlbut, Robert C. Kammerling, Gemology, Wiley, 1990.
- Cally Hall, Gemstones: Properties, Identification and Use, DK Publishing, 2000.



- Michael O'Donoghue, Gems: Their Sources, Descriptions, and Identification, Butterworth-Heinemann, 2006.
- Basil W. Anderson, James Payne, The Spectroscope and Gemmology, GemStone Press, 1998.
- Eduard J. Gübelin, John I. Koivula, Photoatlas of Inclusions in Gemstones. Opinio Publishers, 2005.
- Verena Pagel-Theisen, Diamond Grading ABC: The Manual, Rubin & Son, 2001.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	–	–	–	–
CO2	2	3	3	1	1	–	–
CO3	2	2	2	1	2	1	1
CO4	1	2	2	3	1	3	1
CO5	1	2	2	–	3	2	3

- The course outcomes of the subject can be mapped with SDGs as below:

CO	Mapped SDGs
CO1	SDG 4, SDG 9
CO2	SDG 4, SDG 8, SDG 9, SDG 12
CO3	SDG 4, SDG 8, SDG 9, SDG 12
CO4	SDG 4, SDG 9, SDG 12
CO5	SDG 4, SDG 8, SDG 9, SDG 12, SDG 16



Specialized Elective

GEO 504 Geohydrology and Water Resource Management

Credits:4

Course No:	Course Name: Geohydrology and Water Resource Management				Course Code: HEO 504		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: To equip M.Sc. Geology students with a comprehensive understanding of subsurface and surface hydrological processes, aquifer characteristics, groundwater flow dynamics, and sustainable water resource management practices. The course integrates geological, geophysical, and geochemical approaches to address challenges related to water availability, quality, and conservation.

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

CO1: define key concepts of groundwater hydrology and **explain** sources, occurrence, and distribution of groundwater.

CO2: measure groundwater quality parameters and **apply** criteria to assess its suitability for domestic, irrigation, and industrial uses.

CO3: interpret water table fluctuations and **analyze** groundwater flow using Darcy's law and contour mapping techniques.

CO4: assess groundwater potential using geophysical and hydrologic investigation methods and **evaluate** exploration techniques for wells and sub-surface mapping.

CO5: design groundwater development plans, including rainwater harvesting, and **develop** solutions to groundwater-related problems in urban, mining, and infrastructure projects.

Course Content:

Unit I: Ground Water Geology; Introduction, history of groundwater development, the importance of groundwater; Elements of groundwater hydrology; Sources of groundwater and origin, hydrological cycle, occurrence and distribution of groundwater, hydrological properties of rocks.



Unit II: Groundwater quality: factors affecting the quality of groundwater, analysis of groundwater, identification in terms of suitability of groundwater for domestic, irrigation, and industrial purposes; Hydrogeology of India, wetlands with special reference to Himachal Pradesh and adjoining states.

Unit III: Water table fluctuations; Causative factors, Water Table Contour Maps; Theory of groundwater flow; Darcy's law and its application, determination of permeability in the laboratory and field; Types of wells, Drilling methods, and Construction Design.

Unit IV: Exploration and Evaluation of groundwater, hydrologic investigation; surface geophysical methods, seismic methods, and electric resistivity methods; Introduction to sub-surface; Geophysical methods.

Unit V: Groundwater problems related to foundation work, mining, canals and tunnels. problems of overexploitation and groundwater mining, groundwater development in urban areas. rainwater harvesting, and groundwater potentials of Himachal Pradesh.

Recommended Readings:

- Todd, D.K.. 1988, Ground Water Hydrology, John Wiley & Sons, New York.
- Davies, S.N., De-West., and R.J.N., 1966, Hydrogeology, John Willey & Sons, New York.
- Hiscock, K.M. and Bense, V.F., 2014, Hydrogeology: Principles and Practice Wiley-Blackwell, 2nd Edition.
- Raghunath, H.M., 1983, Ground Water, Wiley Eastern Ltd., Calcutta.
- Driscoll, F.G., 1988, Ground Water and Wells, UOP, Johnson Div. St. Paul. Min. USA
- Freeze. R.A. and Cherry, J.A., 1971, Groundwater.
- Fetter, C.W., 1990, Applied Hydrology.
- Karanth, K.R., 1987, Groundwater assessment, Development and Management.
- Alley, W.M., 1983, Regional groundwater quality.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	2	3	2	3	2	2
CO3	1	2	3	3	2	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	3	3	3



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 6
CO2	SDG 3, SDG 6, SDG 12
CO3	SDG 6, SDG 9
CO4	SDG 6, SDG 9
CO5	SDG 6, SDG 11, SDG 12, SDG 13

GEO 515: Composition and Evolution of Continental Crust

Credits:4

Course No:	Course Name: Composition and Evolution of Continental Crust				Course Code: GEO 515		
Batch: 2026-2027	Programme: M.Sc. Geology	Semester: III	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: This course aims to develop foundational knowledge and conceptual clarity on the composition, structure, and evolution of the continental crust while enhancing analytical and problem-solving skills through the interpretation of geochemical, geophysical, and isotopic data. It seeks to promote critical thinking and scientific inquiry in evaluating models of crustal growth, recycling, and differentiation, and to build an interdisciplinary understanding of Earth systems by linking crust–mantle interactions with geodynamics and plate tectonics. The course further strives to strengthen practical and interpretative skills in handling geological datasets such as sedimentary records and isotopic signatures, encourage research orientation and independent learning in emerging areas of early Earth evolution and tectonic transitions, and foster environmental and societal awareness by highlighting the role of crustal processes in resource distribution and Earth system sustainability.



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

CO1: Define and **outline** the structure, composition, and methods of determining the continental crust.

CO2: Explain and **summarize** the different models of crustal composition and supporting geochemical evidence.

CO3: Apply and **demonstrate** the use of sedimentary and isotopic records to interpret secular variation in crustal composition.

CO4: Analyze and **differentiate** between various crustal growth models and their geological and isotopic constraints.

CO5: Evaluate and **design** models explaining crust–mantle interactions and the onset of plate tectonics.

Course Content:

Unit I: Composition of the Continental Crust: What is the Continental Crust?; The Importance of Determining Crust Composition; Hadean Crust (early, mid and late Hadean); the upper continental crust; methods for determining composition; Sampling Continental Crust; Chemical composition of the upper crust;

Unit II: Models of Total crustal Composition: Heat flow and radioactive element abundance; andesitic model; underplating model; Archean bimodal basic felsic igneous model; Middle crust: Samples, evidence and Middle crustal composition; The lower crust: Sampling problems; xenoliths; basic or acidic lower crust; Isotopic studies; Proposed composition of the lower crust; bulk crustal composition and comparison

Unit III: Uniformity of crustal composition with time: measurement of secular variation; Sedimentary record; role of sedimentary recycling; Nd model ages of sediments; Phanerozoic and Archean greywackes and their comparison; The Archean Crust: Archean record; Low grade terrains (volcanic rocks, isotopic variation in volcanic rocks, Sedimentary rocks); cratonic terrains (TTGs, Sanukitoids, High-K granitoids), tectonic models, crustal thickness, regional geochemistry, trace elemental signatures, composition of Archean crust,

Unit IV: Archean Proterozoic Boundary: late Archean igneous activity and crustal recycling; Models of evolution of Continental crust: The Archean crust, Archean Proterozoic transition; post Archean Crust; the models of evolution of granite in Early-Archean, late Archean and Proterozoic; The development of present day plate tectonics; The Growth rate of the crust: Models of Crustal growth; Geological constraints; isotopic constraints in Early -late and Post Archean Crustal growth;

Unit V: Crust mantle relationships: The origin of Earth, upper and lower mantle compositions, primitive mantle compositions; effects of crustal extraction, crustal recycling (geochemical evidence, Sr, Nd and Hf isotopes, Th/U ratios); Oceanic crust; When did plate tectonics began: evidence from Preservation of modern plate tectonic features, detrital zircon spectra, trace element and isotope geochemistry, Stagnant to mobile lid transition.

Recommended Readings:



- Korenaga, J., 2018. Crustal evolution and mantle dynamics through Earth history. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 376(2132).
- Harrison, T.M., 2024. We don't know when plate tectonics began. *Journal of the Geological Society*, 181(4), pp.jgs2023-212.
- Korenaga, J., 2021. Was there land on the early Earth?. *Life*, 11(11), p.1142.
- Taylor, S.R. and McLennan, S.M., 1985. The continental crust: its composition and evolution.
- Taylor, S.R. and McLennan, S.M., 1981. The composition and evolution of the continental crust: rare earth element evidence from sedimentary rocks. *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences*, 301(1461), pp.381-399.
- Nance, W.B. and Taylor, S.R., 1976. Rare earth element patterns and crustal evolution—I. Australian post-Archean sedimentary rocks. *Geochimica et Cosmochimica Acta*, 40(12), pp.1539-1551.
- Nance, W.B. and Taylor, S.R., 1976. Rare earth element patterns and crustal evolution—I. Australian post-Archean sedimentary rocks. *Geochimica et Cosmochimica Acta*, 40(12), pp.1539-1551.

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	2	2	2	1	1
CO3	2	2	3	2	2	2	2
CO4	1	2	3	3	2	2	2
CO5	1	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय
Central University of Himachal Pradesh
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Shahpur, Distt. Kangra (HP) - 176206
Website: www.cuhimachal.ac.in



Course Outcome (CO)	Mapped SDGs
CO2	SDG 4, SDG 9
CO3	SDG 9, SDG 13
CO4	SDG 4, SDG 9
CO5	SDG 9, SDG 13



Semester IV

GEO 508: Analytical Petrology and Geochemistry

Credits:4

Course No:	Course Name: Analytical Petrology and Geochemistry				Course Code: GEO 508		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective: The objective of this course is to equip students with in-depth knowledge and practical skills in advanced analytical and geophysical instrumentation used in geological investigations. The course aims to develop proficiency in the principles, operation, and applications of modern instruments such as X-ray diffraction (XRD), X-ray fluorescence (XRF), scanning electron microscopy (SEM), electron probe microanalysis (EPMA), inductively coupled plasma mass spectrometry (ICP-MS), and various geophysical survey tools. Emphasis is placed on data acquisition, interpretation, and the integration of instrumental techniques in solving complex geological problems.

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

CO1: define the scope and importance of analytical geochemistry, and **explain** sampling protocols, contamination control, and methods for sample preparation and dissolution.

CO2: apply XRD and XRF techniques to determine major and trace element compositions, and **compare** and classify analytical outputs while illustrating calibration procedures, advantages, and limitations of these methods.

CO3: analyze SEM images, BSE, and CL data to characterize minerals, and **differentiate** the capabilities of EPMA for quantitative chemical analysis in geological applications.

CO4: evaluate the suitability of ICP-AES, AAS, ICP-MS, and MC-ICPMS for specific geochemical analyses, and **assess** data quality, accuracy, and detection limits in trace element determination.



CO5: formulate strategies to select appropriate TIMS, SIMS, or accelerator mass spectrometry techniques for isotopic studies, and **design** analytical workflows for modern ion microprobe applications.

Course Content:

Unit I: Fundamentals of Analytical Geochemistry; Scope and importance of analytical geochemistry; Types of geochemical analysis: qualitative vs quantitative; major, minor, and trace elements; Sampling protocols and contamination control;

Unit II: Sample dissolution methods: acid digestion, fusion techniques; Internal standards and calibration curves; Accuracy, precision, detection limits, and data quality; Standard Error; Random error; Sampling and Sample preparation techniques.

Unit III: X-ray Diffraction (XRD): Principles, instrumentation; X-ray Fluorescence (XRF): Major, trace element analysis, advantages, and limitations;

Unit IV: Scanning Electron Microscopy (SEM); Backscattered electron (BSE) images and Cathode Luminescence (CL) Imaging, Electron Probe Micro Analyzer (EPMA): Quantitative chemical analysis of minerals; Applications in geology.

Unit V: Mass Spectrometry; Inductively Coupled Plasma atomic emission spectrometry (ICP-AES); Atomic Absorption spectrometry (AAS); Inductively Coupled Plasma Mass Spectrometry (ICP-MS); Multicollector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS); Thermal Ionization Mass Spectrometry (TIMS); Accelerator mass spectrometry; Principles of SIMS and modern ion microprobes; Which method should I use?

Recommended Readings:

- Potts, P. J. A handbook of Silicate rock analysis
- Dickin, A.P. "Radiogenic Isotope Geology" Cambridge University Press, 2005.
- Faure, G. and Mensing, T. M., "Isotopes: Principles and Applications", John Wiley, New York, 2004
- Rollinson, H., "Using geochemical data: evolution, presentation, interpretation" Pearson Education Limited, 1993

PO-CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	3	3	2	2	2	2
CO3	1	2	3	3	2	2	2



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 12
CO2	SDG 9, SDG 12
CO3	SDG 4, SDG 9
CO4	SDG 9, SDG 12
CO5	SDG 4, SDG 9, SDG 13

GEO 513: Practical (Paper Publications/Seminar-Conference presentation at national level

Credits:2

Course	Course Name: Practical (Paper Publications/Seminar-Conference presentation at national level				Course Code: Geo 513		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L 4	T 0	P 0	Credits 4	Contact Hrs. per Week: Total Hrs.:
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: This course aims to develop scientific writing, publication, and presentation skills among students. It trains them to prepare research manuscripts and /or present their work at national-level seminars and conferences while familiarizing them with



peer-review processes, journal selection, and publication ethics. The course also enhances academic communication and professional networking abilities.

Course outcomes: At the end of the course the students will be able to:

CO1: Define and **summarize** the structure and components of scientific work in papers and/or conference presentations.

CO2: Illustrate and **implement** academic writing techniques to prepare research manuscripts and or conference abstracts.

CO3: Assess and **formulate** strategies for effective oral and poster presentations at conferences.

CO4: Execute and **differentiate** appropriate journal/conference selection and manuscript/abstract submission processes.

Course Content: The students in this course need to present their research at a national level conference or publish their research findings in a peer-reviewed journal/book chapter. Conference participation Certificate/front page of the article is to be submitted to obtain the given credits.

Recommended Readings: Na

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: 3 = **High**, 2 = **Moderate**, 1 = **Low**, – = **no correlation**

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

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 12



GEO 514: Academic Writing

Credits:2

Course No:	Course Name: Academic Writing				Course Code: Geo 514		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 2 Total Hrs.: 30
			2	0	0	2	
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 100➤ Mid-Term Examination (20%): 20➤ End-Term Examination (60%): 60➤ Continuous Internal Assessment (20%): 20							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective: The course on Academic Writing is designed to develop students' ability to communicate ideas clearly, logically, and effectively in scholarly contexts. It aims to build proficiency in structuring academic texts, including essays, reports, and research papers, while emphasizing coherence, argumentation, and critical thinking. The course also focuses on enhancing skills in paraphrasing, summarizing, referencing, and avoiding plagiarism, in accordance with academic integrity standards. By the end of the course, students will be able to analyze sources, synthesize information, and produce well-organized, evidence-based writing suitable for academic and professional purposes.

Course outcomes: At the end of the course the student will be able to:

CO1: define the principles of academic writing and **explain** the structure and components of scientific communication.

CO2: apply appropriate methodologies in thesis preparation and **organize** different sections of a dissertation effectively.

CO3: analyze the structure and formats of research papers and **differentiate** between various journal metrics and referencing styles.

CO4: evaluate the effectiveness of oral and poster presentations and **critique** the ethical use of academic tools including plagiarism detection and AI.

CO5: design well-structured academic documents and **construct** error-free, coherent scholarly texts for publication.

Course content:

Unit I: Introduction: Introduction and importance of academic and research writing; characteristics of effective academic writing; various kinds of academic documents (essays, reports, reviews, research papers); approaches to academic writing; the IMRaD format; general structure and components of scientific reports; clarity, precision, and objectivity in writing; general rules of good scientific writing; common errors and strategies for improvement



Unit II: Thesis writing: Concept, layout, and structure of a thesis/dissertation; formulation of research problems and objectives; writing the introduction; literature review and identification of research gaps; research methodology and design; preliminary studies and data collection; presentation of results and discussions; preparation of figures, tables, and illustrations; writing conclusions and future scope; bibliography and referencing styles; appendices and formatting guidelines.

Unit III: Research paper writing: Types of research papers (original articles, reviews, short communications, case studies); structure and formats of research papers; journal selection and submission process; writing effective abstracts and keywords; methodology, results, and discussion sections; referencing styles (APA, MLA, Chicago, etc.); communication of research through journals and conferences; understanding journal metrics (impact factor, citation index, h-index); ISBN and ISSN; author-level and journal-level metrics.

Unit IV: Oral/poster presentation and other academic writing tools/techniques: Principles of effective oral presentations; designing and delivering academic presentations; preparation and presentation of scientific posters for conferences and symposiums; visual communication techniques; use of plagiarism detection tools; academic integrity and UGC guidelines; avoiding plagiarism and ethical writing practices; introduction to digital tools and software for academic writing; role and ethical use of AI in academic writing.

Unit V: Editing, Proofreading, and Scholarly Communication Techniques of editing and proofreading academic texts; improving coherence, cohesion, and readability; peer review process and responding to reviewers' comments; writing book reviews, project reports, and technical documents; citation management tools; publication ethics and avoiding predatory journals; open access publishing; dissemination of research through academic networks and platforms.

Recommended Readings

- https://www.ugc.gov.in/pdfnews/7771545_academic-integrity-Regulation2018.pdf
- https://www.ugc.gov.in/e-book/Academic%20and%20Research%20Book_WEB.pdf
- <https://www.ugc.gov.in/e-book/Academic%20and%20Research/mobile/index.html>
- "Writing Scientific Research Articles: Strategy and Steps" by Margaret Cargill and Patrick O'Connor, John Wiley & Sons, 20 Apr 2009, ISBN 1405193352, 9781405193351
- Mastering Academic Writing in the Sciences: A Step-by-Step Guide" by Marialuisa Aliotta, Publisher CRC Press, Taylor & Francis Group, 2018, ISBN 1138742880, 9781138742888

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	1	2	1	2
CO2	2	2	3	2	2	3	2
CO3	2	3	2	2	2	2	2
CO4	1	2	2	2	3	2	3
CO5	1	2	2	2	2	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 4, SDG 12, SDG 16
CO5	SDG 4, SDG 9

GEO 599: Dissertation and Viva Voce

Credits: 8

Course No:	Course Name: Dissertation and Viva Voce				Course Code: GEO 599		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L	T	P	Credits	Contact Hrs. per Week:
			4	0	0	4	Total Hrs.:
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark:➤ Mid-Term Examination (20%):➤ End-Term Examination (60%):➤ Continuous Internal Assessment (20%):							



Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.

Course Objectives: The main objective the course is to introduce the students to learn basic methods of research activities carried out in geosciences by which the students will understand how to identify geological problems and the methods to solve them using various tools.

Course Outcome: After the completion of the course, the students will be expected to have:

CO1: identify a geological research problem and **explain** the scope and significance of their study within the context of Earth sciences.

CO2: implement systematic data collection and analytical techniques and **demonstrate** the use of field and laboratory methods in addressing the research problem.

CO3: analyze the collected data using appropriate scientific methods and **interpret** results to derive meaningful geological insights.

CO4: evaluate the significance and reliability of their findings and **critique** their results in comparison with existing literature.

CO5: synthesize their research into a comprehensive dissertation and **formulate** potential scientific publications or recommendations for further studies.

Course content:

The project work shall be carried out for a period of minimum one semester under the supervision of a faculty in the department. Students shall be assigned to a supervisor at the beginning of third semester. A research problem in geology shall be identified and solved by systematic scientific study. At the end of fourth semester, students should submit their dissertation, duly signed by their respective supervisor, to the department which will be followed by presentation and viva-voce.

The students are also encouraged to write a research article from their work for publication in a peer-reviewed journal.

Recommended Readings

The readings will be as per the Dissertation topic

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	2	1	1



CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C02	2	2	3	2	2	2	2
C03	1	2	3	3	2	2	2
C04	1	1	2	3	3	2	2
C05	—	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 9
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 13
CO4	SDG 4, SDG 16
CO5	SDG 4, SDG 9, SDG 12



Advanced Specialized Courses

GEO 509: Advanced Igneous Petrology

Credits: 4

Course No:	Course Name: Advanced Igneous Petrology				Course Code: GEO 509		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objectives: The main objective of the course is to understand the igneous processes and rocks and how the properties of magma and magmatic processes are reflected in igneous rocks.

Course outcomes: On completion of the course the students will be able to:

CO1: define classifications of igneous rocks and **explain** the significance of textures and microstructures in magmatic history.

CO2: calculate normative mineralogy and CIPW norms and **demonstrate** the interpretation of field relationships and emplacement features of igneous bodies.

CO3: analyze geochemical data including major, trace, and rare earth elements, and **interpret** petrogenetic processes using geochemical diagrams.

CO4: assess the relationship between magmatism and global tectonic processes and **compare** magma characteristics across different tectonic settings.

CO5: synthesize knowledge of mantle processes and magmatic differentiation to **formulate** models for magmatism at various plate margins and intra-plate settings.

Course Content:

Unit I: Classification, textures and Structures of Igneous Rocks and their significance in magmatic history; Classification and genesis of ultramafic, mafic, intermediate, and felsic rocks; Field relationships and emplacement features of igneous bodies

Unit II: Thermodynamics of melting and crystallization, Partial melting processes: mantle and crustal sources; Primary versus evolved magmas; Fractional crystallization, assimilation,



magma mixing, and contamination; Major, trace, and rare earth elements in igneous rocks; Geochemical diagrams for petrogenetic interpretations

Unit III: Relation of present-day magmatism to global tectonic processes; Characterisation of magma series with specific tectonic setting; Chemical analysis of igneous rocks; Chemical Variation diagrams; geochemical characterization of primary magmas; isotopes as petrogenetic indicators; geochemical criteria for the identification of paleotectonic setting of ancient volcanic sequences; Modelling trace element processes in igneous rocks

Unit IV: Physical state of the upper mantle, Chemical composition and mineralogy of the upper mantle; partial melting processes in the upper mantle; basaltic magma spectrum in relation to the partial melting processes; segregation and ascent of magma; processes that modify the composition of primary magma

Unit V: Magmatism at Constructive plate margins; Magmatism at destructive plate margins; active continental margins; back arc basins; magmatism within plates; oceanic islands; continental tholeiitic flood basalt provinces; continental rift zone magmatism; Potassic magmatism within continental plates

Recommended Readings:

- Philpotts, A.R. and Ague, J.J., "Principles of Igneous and Metamorphic Petrology" Cambridge University Press 2010
- Winter, J., "An Introduction to Igneous and Metamorphic Petrology", Prentice-Hall 2001
- Hall, A., "Igneous Petrology", John Wiley & Sons 1995
- Rollinson, H., "Using geochemical data: evolution, presentation, interpretation" Pearson Education Limited 1993
- Willson, M., "Igneous Petrogenesis: A Global Tectonic Approach", UnwinHyman 1989
- Cox, K.G., Bell, J.D. and Pankhurst, R.J., "The Interpretation of Igneous Rocks" George Allen and Unwin Publishers Ltd. 1979

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	2	3	2	2	2	2
CO3	1	2	3	3	2	2	2
CO4	1	2	2	3	3	2	2
CO5	1	1	2	2	3	3	3



- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 9
CO4	SDG 9, SDG 13
CO5	SDG 4, SDG 9, SDG 13

GEO 510: Advanced Remote Sensing and GIS applications

Credits: 4

Course No:	Course Name: Advanced Remote Sensing and GIS applications				Course Code: GEO 510		
Batch: 2026-2027	Programme: M. Sc. Geology	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 4
			4	0	0	4	Total Hrs.: 60
Evaluation Criteria <ul style="list-style-type: none">➤ Total Evaluation Mark: 200➤ Mid-Term Examination (20%): 40➤ End-Term Examination (60%): 120➤ Continuous Internal Assessment (20%): 40							
Attendance Requirement: Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must; failing which, a student may not be permitted to appear in the examination.							

Course Objective: This course aims to provide students with specialized knowledge and technical expertise in advanced remote sensing and GIS techniques for geological investigations.

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

CO1: describe the fundamentals and platforms of remote sensing and **explain** interactions of electromagnetic radiation with Earth materials.

CO2: perform digital image processing tasks and **classify** images using supervised, unsupervised, and object-based techniques.

CO3: analyze spatial data using GIS techniques and **interpret** DEMs, 3D surface models, and terrain attributes for geological and environmental applications.



CO4: to **assess** geospatial datasets for hydrogeological, mineral exploration, and geohazard studies and **evaluate** the accuracy of classification and spatial analysis results.

CO5: **integrate** remote sensing, GIS, and GPS datasets and **design** thematic and geological maps for research, consultancy, and decision-making purposes.

Course Content:

Unit I: Fundamentals and Platforms of Remote Sensing; Electromagnetic spectrum and interactions with earth materials; Multispectral, hyperspectral, and thermal remote sensing; Active remote sensing: SAR, LiDAR principles and applications; Overview of satellites and sensors: Landsat, Sentinel, Cartosat, ASTER, Hyperion, MODIS, IRS series; Aerial photography and UAV-based remote sensing; Data acquisition platforms: satellite, airborne, drone-based

Unit II: Digital Image Processing Techniques; Image rectification, enhancement, and filtering techniques; Radiometric and geometric corrections; Image classification techniques: supervised, unsupervised, object-based classification; Advanced classification algorithms: Support Vector Machines (SVM), Random Forest (RF); Change detection techniques; Spectral indices (NDVI, NDBI, NDWI) and geological indices (Band Ratios for lithological discrimination)

Unit III: Advanced GIS Concepts and Spatial Analysis; GIS data models: raster and vector data structures; Spatial analysis techniques: overlay analysis, buffering, network analysis; Digital Elevation Models (DEMs): SRTM, ASTER, CartoDEM, and LiDAR DEMs; 3D surface analysis and terrain modelling; Spatial interpolation and kriging; Introduction to geodatabases and spatial data management

Unit IV: Applications in Geological and Environmental Studies; Lithological and structural mapping using remote sensing and GIS; Lineament analysis and fracture detection; Mineral exploration and hydrothermal alteration mapping; Groundwater potential zonation and aquifer mapping; Geohazard assessment: landslides, floods, earthquakes; Urban growth modeling and land use/land cover change detection

Unit V: Advanced Tools, Integration Techniques, and Case Studies; Integration of remote sensing, GIS, and GPS datasets; Use of open-source and commercial software (e.g., QGIS, ArcGIS, ERDAS Imagine, ENVI); Big data and cloud-based platforms: Google Earth Engine (GEE); Machine learning and AI in remote sensing; Case studies from India (e.g., Himalayas, Western Ghats, Deccan Plateau) and international projects; Preparation of geological and thematic maps for research and consultancy projects

Recommended Readings:

- Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, Remote Sensing and Image Interpretation, Wiley, 2015
- George Joseph, Fundamentals of Remote Sensing, Universities Press, 2018
- Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, Geographic Information Systems and Science, Wiley, 2015



- Peter A. Burrough, Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2011
- Gary L. Prost, Remote Sensing for Geologists: A Guide to Image Interpretation, CRC Press, 2013
- Eric C. Barrett, L. F. Curtis, Introduction to Environmental Remote Sensing, Routledge, 2012

PO–CO Mapping Matrix for the given Course Outcomes (COs) and previously defined Program Outcomes (POs).

The correlation is indicated as: **3 = High, 2 = Moderate, 1 = Low, – = no correlation**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	–	1
CO2	2	2	3	2	2	2	2
CO3	1	2	3	3	2	2	2
CO4	1	1	2	2	3	2	2
CO5	–	1	2	2	3	3	3

- The course outcomes of the subject can be mapped with SDGs as below:

Course Outcome (CO)	Mapped SDGs
CO1	SDG 4, SDG 13
CO2	SDG 4, SDG 9
CO3	SDG 4, SDG 15
CO4	SDG 6, SDG 9, SDG 13
CO5	SDG 9, SDG 11, SDG 13

Documents attached on all the pages from 1 to 96 are approved

Rohi

Naveen Chaudhary

Santosh

Signature of the Head of Institution