THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF ENVIRONMENTAL AND EARTH SCIENCES

(RSEES)

DEPARTMENT OF GEOLOGY

COURSE STRUCTURE & SYLLABUS

FOR

M.Sc. GEOLOGY

W.E.F.
A.Y. 2025-26

(Based on National Education Policy 2020)

M. Sc. Geology

Two-Year Programme Structure

1st SEMESTER

Sl. No	Course Code	Name of Courses	Course Scheme	Course Level	Credits
1	GEOL164C101	Structural Geology and Tectonics	T	500	3
2	GEOL164C112	Structural Geology Practical	P	500	1
3	GEOL164C103	Mineralogy and Crystal Chemistry	T	400	3
4	GEOL164C114	Mineralogy Practical	P	400	1
5	GEOL164C105	Igneous and Metamorphic Petrology	T	500	3
6	GEOL164C116	Igneous and Metamorphic Practical	P	500	1
7	GEOL164C107	Sedimentology and Quaternary Geology	T	500	3
8	GEOL164C118	Sedimentology Practical	P	500	1
9	GEOL164C109	Climatology and Oceanography	T	400	4
10		**Course through SWAYAM portal** *(to be selected by the department)*	T		3 or 4
				TOTAL	20 + (3 or 4)

2nd SEMESTER

Sl. No	Course Code	Name of Courses	Course Scheme	Course Level	Credits
1	GEOL164C201	Indian Stratigraphy and Applied Palaeontology	T	400	3
2	GEOL164C212	Stratigraphy and Palaeontology Practical	P	400	1
3	GEOL164C203	Geomorphology	T	500	3
4	GEOL164C214	Geomorphology Practical	P	500	1
5	GEOL164C205	Geology of North-East India	T	400	4
6	GEOL164C206	Planetary Geology	T	400	4
7	GEOL164C207	Urban Geology	T	400	4
8		**Course through SWAYAM portal** *(to be selected by the department)*	T		3 or 4
				TOTAL	20 + (3 or 4)

Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma

3rd SEMESTER

Sl. No	Course Code	Name of Courses	Course Scheme	Course Level	Credits
1	GEOL164C301	Engineering Geology	T	500	3
2	GEOL164C312	Engineering Geology Practical	P	500	1
3	GEOL164C303	Economic Geology	T	500	3
4	GEOL164C314	Economic Geology Practical	P	500	1
5	GEOL164C305	Fuel Geology	T	500	3
6	GEOL164C316	Fuel Geology Practical	P	500	1
7	GEOL164C327	Pre-Dissertation Research	P	-	8
				TOTAL	20

4th SEMESTER

Sl. No	Course Code	Name of Courses	Course Scheme	Course Level	Credits
1	GEOL164C401	Exploration Geology	T	500	4
2	GEOL164C402	Mining Geology	T	500	4
3	GEOL164C423	Dissertation	P	-	12
				TOTAL	20

M. Sc. Geology

One-Year Programme Structure

1st SEMESTER					
Sl. No	**Course Code**	**Name of Courses**	**Course Scheme**	**Course Level**	**Credits**
1	GEOL164C301	Engineering Geology	T	500	3
2	GEOL164C312	Engineering Geology Practical	P	500	1
3	GEOL164C303	Economic Geology	T	500	3
4	GEOL164C314	Economic Geology Practical	P	500	1
5	GEOL164C305	Fuel Geology	T	500	3
6	GEOL164C316	Fuel Geology Practical	P	500	1
7	GEOL164C327	Pre-Dissertation Research	P	-	8
				TOTAL	20
2nd SEMESTER					
Sl. No	**Course Code**	**Name of Courses**	**Course Scheme**	**Course Level**	**Credits**
1	GEOL164C401	Exploration Geology	T	500	4
2	GEOL164C402	Mining Geology	T	500	4
3	GEOL164C423	Dissertation	P	-	12
				TOTAL	20

Detailed Syllabus
Two-Year M.Sc. Programme
Semester 1

Course Level: 500	STRUCTURAL GEOLOGY AND TECTONICS L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C101

Course Objective: To provide an advanced understanding of deformation processes in the Earth's crust, integrating structural geology principles with plate tectonic mechanisms while developing analytical and field-based skills for geological interpretation.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define and recall fundamental concepts of stress, strain, rock deformation, and tectonic structures.	**BT 1**
CO 2	Understand the mechanics of rock deformation and classify different types of folds, faults, joints, and shear zones.	**BT 2**
CO 3	Apply strain analysis techniques and stereographic projections to interpret structural data.	**BT 3**
CO 4	Analyse deformation patterns to differentiate between brittle and ductile processes and their geological significance.	**BT 4**
CO 5	Evaluate the role of structural geology in tectonics, seismic activity, and resource exploration using field and remote sensing data.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Structural Geology** Introduction to rock mechanics: Stress and strain in rocks, stress tensor, strain tensor, finite and infinitesimal strain. Mohr stress circle and determination of the direction of shear stress. Principal axes of strain; measurement of strain using Flinn's diagram, Fry's method, and other strain markers. Behaviour of rocks under stress: elastic, plastic, brittle, viscous, and visco-elastic responses and their geological significance. Failure criteria: Coulomb's failure criterion, Griffith's theory of fracture. Planar and linear structures in deformed rocks: Cleavage, lineation, foliation and their kinematic significance.	12
Unit 2	**Folding, Faulting, and Jointing** Classification of folds: Ramsay's (1967) and Fleuty's (1964) classifications. Kinematics of folding: buckle folds, shear folds, and flexural slip folds. Determination of shear sense from fold geometry; superposed folding and interference patterns. Boudinage: Morphology, origin, and relationship to folding. Mechanics of faulting: Anderson's theory of faulting and its limitations. Geometry and kinematics of normal, strike-slip, and thrust faults with natural examples. Concept of fault zone weakening, fault reactivation, and seismotectonics. Geometric analysis of joints: Tectonic, columnar, and release joints.	12
Unit 3	**Shear Zones and Lithospheric Deformation** Shear zones: Geometry, kinematics, and classification. Strain analysis in shear zones: Shear sense indicators. Flow behaviour of sheared rocks: Ductile and brittle-ductile shear zones. Shear zone rocks: Cataclasite, gouge, breccia, mylonite, pseudotachylyte. Microstructures and their significance. Role of shear zones in the evolution of the continental crust.	10

Unit 4	**Tectonics and Structural Applications** Lithospheric plates, plate boundaries, and associated deformation. Orogeny and mountain-building processes: Himalayan tectonics, Andean-type orogeny. Subduction zones, mid-ocean ridges, and transform faults. Concept of Thrust-Tectonics. Triple Junctions and their stability criteria. Concept of spherical motion and Euler's pole in plate tectonics. Tectonic significance of structural geology in earthquake generation, magmatism, and basin evolution. Applications of structural geology in petroleum geology, mineral exploration, and engineering geology. Integration of remote sensing and GIS in structural geology.	11
	Total	**45**

Text Books:

1) Structural Geology - Robert J. Twiss & Eldridge M. Moores, (2nd edition, 2007), W. H. Freeman & Co Ltd.
2) Structural Geology – Haakon Fossen, (2010), Cambridge University Press, New York.
3) Structural Geology- Fundamentals & Modern Developments (1993) - S K Ghosh, Pergamon Press.

Reference Books:

1) Pluijim, B.A.V.D. and Marshak, S., 2003: Earth Structure; 2nd edn., W.W. Norton & Co.
2) Pollard, D.D.,2005: Fundamentals of Structural Geology; Cambridge Univ. Press.

Course Level: 500	STRUCTURAL GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C112

Course Objectives: To provide an advanced understanding of deformation processes in the Earth's crust, integrating structural geology principles with plate tectonic mechanisms while developing analytical and field-based skills for geological interpretation.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define and recall fundamental concepts of stress, strain, rock deformation, and tectonic structures.	**BT 1**
CO 2	Understand the mechanics of rock deformation and classify different types of folds, faults, joints, and shear zones.	**BT 2**
CO 3	Apply strain analysis techniques and stereographic projections to interpret structural data.	**BT 3**
CO 4	Analyse deformation patterns to differentiate between brittle and ductile processes and their geological significance.	**BT 4**
CO 5	Evaluate the role of structural geology in tectonics, seismic activity, and resource exploration using field and remote sensing data.	**BT 5**

Modules	Topics and Course Content	Hours
I	**Construction and interpretation of Mohr's stress circle** From given stress tensor data. Identification of principal stress directions and shear stress magnitudes. **Measurement of finite strain using strain markers** Fry's method and Rf/φ method using stretched clasts or reduction spots. **Plotting and interpretation using Flinn Diagram** Strain data plotting and assessment of flattening vs. constrictional strain. **Analysis and classification of folds using Ramsay's and Fleuty's methods** Based on dip/strike data and fold profile geometries. **Kinematic analysis of folds** Determination of shear sense from asymmetric folds and parasitic folds. **Recognition and interpretation of superposed folding** Drawing and interpretation of interference patterns (Type 0, 1, 2, 3). **Stress analysis using fault-slip data** Identification of stress regime (normal, thrust, strike-slip). **Geometric analysis of joint sets** Interpretation of tectonic, cooling, and release joints. **Microscopic and mesoscopic analysis of shear sense indicators** S-C fabrics, σ-clasts, δ-clasts, mica fish (thin section/photo-based exercises). **Euler pole and spherical plate motion exercises** Plotting relative plate motions and angular displacements. **Case study analysis: Himalayan tectonics** Structural cross-sections, lineaments, and tectonic evolution using maps. **Preparation of rose diagrams and stereographic projections** Analysis of joint/fault orientation data using software or manual methods.	30
Total Notional Credit Hours		**30**

Text Books:

1) Structural Geology - Robert J. Twiss & Eldridge M. Moores, (2nd edition, 2007), W. H. Freeman & Co Ltd.
2) Structural Geology – Haakon Fossen, (2010), Cambridge University Press, New York.
3) Structural Geology- Fundamentals & Modern Developments (1993) - S K Ghosh, Pergamon Press.

Reference Books:

1) Pluijim, B.A.V.D. and Marshak, S., 2003: Earth Structure; 2nd edn., W.W. Norton & Co.
2) Pollard, D.D.,2005: Fundamentals of Structural Geology; Cambridge Univ. Press.

Course Level: 400	MINERALOGY AND CRYSTAL CHEMISTRY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C103

Course Objective: To provide a comprehensive understanding of mineral structures, crystal chemistry, and mineralogical analysis techniques, integrating theoretical concepts with practical applications in geology.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of crystallography, crystal chemistry, and mineral classification.	**BT 1**
CO 2	Understanding the principles of crystal structures, bonding, structural transformations, and mineral properties.	**BT 2**
CO 3	Apply X-ray diffraction and optical techniques for mineral identification and characterization.	**BT 3**
CO 4	Analyse the relationship between mineral structures, composition, and their physical and optical properties.	**BT 4**
CO 5	Evaluate mineral stability, solid solution behaviour, and the role of advanced analytical techniques (SEM, TEM, EPMA) in mineralogical studies.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	Periodicity and symmetry-concept of space lattice, unit cell, and crystal systems. Chemical bonding in Crystal structures: Ionic, covalent and metallic bonding. Ionic radii, coordination number, Pauling's rule for crystal stability. Crystal structure of minerals- Hexagonal close-packing, cubic close-packing and body centred structure. Crystal Defects: Point Defects, Line defects and Planar defects.	12
Unit 2	Chemical classification of minerals; Composition of common rock-forming minerals. Silicate minerals and their structures: Isolated tetrahedra (nesosilicates), Single-chain silicates (inosilicates), Double-chain silicates (amphiboles), Layered silicates (phyllosilicates), Framework silicates (tectosilicates). Non-silicate mineral structures and mineralogy of clays.	12
Unit 3	Structural transformation in minerals: Isomorphism, Polymorphism, and Pseudomorphism. Compositional classification and structural inversion in minerals. Solid solution and exsolution mechanisms: Rules governing solid solution behaviour; examples from pyroxenes and feldspars. Chemical, physical, and optical properties of major silicate mineral groups: olivine, feldspar, pyroxene, amphibole, garnet, and mica.	10
Unit 4	Principles of X-ray crystallography and Bragg's equation. Introduction to diffraction and imaging techniques. X-ray diffraction (XRD): Single-crystal and powder diffraction methods for mineral identification. Reciprocal lattice and Crystal field theory. Application of SEM, TEM and EPMA in mineral characterization.	11
	Total	**45**

Text Books:

1) Deer, Howie & Zussman – Introduction to the Rock-Forming Minerals
2) Klein & Dutrow – Manual of Mineral Science

Reference Books:

1) Putnis – Introduction to Mineral Sciences
2) Nesse – Introduction to Optical Mineralogy
3) Azaroff – Elements of X-ray Crystallography

Course Level: 400	MINERALOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C114

Course Objective: To provide a comprehensive understanding of mineral structures, crystal chemistry, and mineralogical analysis techniques, integrating theoretical concepts with practical applications in geology.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of crystallography, crystal chemistry, and mineral classification.	**BT 1**
CO 2	Understanding the principles of crystal structures, bonding, structural transformations, and mineral properties.	**BT 2**
CO 3	Apply X-ray diffraction and optical techniques for mineral identification and characterization.	**BT 3**
CO 4	Analyse the relationship between mineral structures, composition, and their physical and optical properties.	**BT 4**
CO 5	Evaluate mineral stability, solid solution behaviour, and the role of advanced analytical techniques (SEM, TEM, EPMA) in mineralogical studies.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Silicate Structures and Mineral Groups** Drawing and interpretation of silicate structures: Nesosilicates, Inosilicates (single & double chains), Phyllosilicates, Tectosilicates, Isolated-Tetrahedral Silicates, Double-Tetrahedral Silicates. **Physical and Optical Properties of Rock-forming Minerals (Hand Specimen + Thin Section)** Description and identification of silicate minerals (olivine, pyroxene, amphibole, mica, feldspar, and garnet). Determination of optical indicatrix and optic sign from mineral thin sections.	10
Unit 2	**Structural and Compositional Features** Demonstration and study of: a) Solid solution and exsolution textures (e.g., perthite in feldspar). b) Polymorphism and isomorphism with mineral examples.	5
Unit 3	**Clay and Non-Silicate Mineral Identification** Identification of clay minerals using simple lab techniques. Study of non-silicate minerals (carbonates, oxides) in hand specimen and/or thin section.	5
Unit 4	**X-ray Crystallography and XRD Techniques** Sample preparation for XRD (powder method). Interpretation of XRD patterns for mineral identification. **Analytical Instrumentation for Mineral Characterization** Introduction to SEM, TEM, and EPMA through virtual labs or demonstrations. Mineral chemical composition and imaging using available datasets or case studies. **Application-based Exercises** Interpretation of mineral formulae and structural formulae calculations. Crystal defects: Interpretation of models and impact on mineral properties.	10
	Total	**30**

Text Books:

1) Deer, Howie & Zussman – Introduction to the Rock-Forming Minerals
2) Klein & Dutrow – Manual of Mineral Science

Reference Books:

1) Putnis – Introduction to Mineral Sciences
2) Nesse – Introduction to Optical Mineralogy

Course Level: 500	IGNEOUS AND METAMORPHIC PETROLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C105

Course Objective: To provide an in-depth understanding of the genesis, evolution, and geodynamic implications of igneous and metamorphic rocks using petrographic, geochemical, and thermodynamic approaches.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental igneous and metamorphic processes, including magma generation, crystallisation, and metamorphic transformations.	**BT 1**
CO 2	Understand the geochemical, mineralogical, and textural characteristics of igneous and metamorphic rocks in different tectonic settings.	**BT 2**
CO 3	Application of phase diagrams, geochemical data, and petrological concepts to determine the petrogenesis of igneous and metamorphic rocks.	**BT 3**
CO 4	Analyse various igneous and metamorphic processes by evaluating mineral assemblages, textures, and geochemical trends.	**BT 4**
CO 5	Evaluate the tectonic and thermal evolution of the lithosphere using petrological and geochemical evidence from natural rock samples.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Igneous Processes and Geochemical Characterisation** Partial melting, magma differentiation, and source characterisation. Mantle melting and melt-mantle interaction in different geodynamic settings. Magmatism in mid-ocean ridges, subduction zones, continental and oceanic rift zones, and plume-related settings (hotspots). Major, trace, and isotopic geochemistry in petrogenetic interpretations. Trace element partitioning during equilibrium and fractional crystallisation/melting. Modelling trace element distribution in igneous petrogenesis.	12
Unit 2	**Petrology and Petrogenesis of Igneous Rocks** **Petrology and tectonic significance of major igneous rock types:** Ultramafic rocks (Komatiite, Kimberlite) Ophiolites and layered mafic-ultramafic complexes Alkaline rocks and carbonatites Flood basalts (Deccan Traps, Sylhet Traps) Granitoids and anorthosites – Tectonic discrimination of granitoids, their role in crustal evolution. **Experimental petrology and phase equilibria:** Two-, three-, and four-component phase systems at different pressures and temperatures. **Radiometric dating of igneous rocks and crustal evolution.**	12
Unit 3	**Metamorphic Processes, Reactions, and Textures** Crustal thickening, geothermal gradient, and P-T-t paths. Metasomatism and fluid-rock interactions. Paired metamorphic belts and their plate tectonic significance. Metamorphic zones, metamorphic grade. Thermodynamic basis of metamorphic facies. Mineral assemblages and phase diagrams (ACF, AKF, AFM). Cation exchange reactions and geothermobarometry. **Metamorphic textures and microstructures:** High-strain textures, deformation fabrics, reaction rims, and replacement textures. Analysis of poly-metamorphic and poly-deformed rocks.	10

Unit 4	**Thermodynamics and Advanced Metamorphic Petrology** **Thermodynamics in metamorphism:** Fundamental thermodynamic equations, enthalpy, entropy, and activity, Gibbs Free Energy. Application of the Clausius-Clapeyron equation in metamorphic reactions. Chemical potential and equilibrium in metamorphic systems. **Solution behaviour in metamorphic minerals:** Mixing components, ideal and non-ideal solutions. Raoult's Law and Henry's Law. **Geothermobarometry and petrogenetic grids:** P-T estimates using exchange and net-transfer reactions. Application of mineral chemistry in deciphering metamorphic conditions. **Role of fluids in metamorphism:** Fluid inclusions and their significance in metamorphic petrology. Retrograde metamorphism and re-equilibration.	11
	Total	**45**

Text Books:

1) Best, M.G. – Igneous and Metamorphic Petrology
2) Philpotts & Ague – Principles of Igneous and Metamorphic Petrology

Reference Books:

1) Winter, J.D. – Principles of Igneous and Metamorphic Petrology
2) Turner, F.J. – Metamorphic Petrology
3) Yardley, B.W.D. – Introduction to Metamorphic Petrology
4) Rollinson, H. – Using Geochemical Data: Evaluation, Presentation, Interpretation

Course Level: 500	IGNEOUS AND METAMORPHIC PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C116

Course Objectives: To provide an in-depth understanding of the genesis, evolution, and geodynamic implications of igneous and metamorphic rocks using petrographic, geochemical, and thermodynamic approaches.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental igneous and metamorphic processes, including magma generation, crystallisation, and metamorphic transformations.	**BT 1**
CO 2	Understand the geochemical, mineralogical, and textural characteristics of igneous and metamorphic rocks in different tectonic settings.	**BT 2**
CO 3	Application of phase diagrams, geochemical data, and petrological concepts to determine the petrogenesis of igneous and metamorphic rocks.	**BT 3**
CO 4	Analyse various igneous and metamorphic processes by evaluating mineral assemblages, textures, and geochemical trends.	**BT 4**
CO 5	Evaluate the tectonic and thermal evolution of the lithosphere using petrological and geochemical evidence from natural rock samples.	**BT 5**

Modules	Topics and Course Content	Hours
I	**Igneous Petrology Practical** 1. Use of phase diagrams (binary and ternary systems) to interpret magma crystallisation trends. 2. Geochemical analysis for petrogenetic interpretation – Use of major and trace element data to determine palaeotectonic settings of igneous rocks. 3. Numerical and graphical problems on magma dynamics: o Solid-liquid equilibrium system. o Magma viscosity and ascent rate. o Fractional crystallisation, partial melting, assimilation, and magma mixing (petrogenetic modelling).	10
II	**Metamorphic Petrology Practical** 4. Recognition of reaction textures, porphyroblastic growth, and deformation features through microscopic study of metamorphic rocks. 5. Identification of index minerals and determination of metamorphic grade. 6. Use of phase diagrams to interpret P-T conditions of metamorphism (ACF, AKF, AFM diagrams). 7. Geothermobarometry calculations using mineral assemblages – Estimation of pressure-temperature conditions of metamorphic reactions. 8. Petrofabric analysis of metamorphic rocks – Measurement of preferred orientation of minerals. 9. Determination of strain and deformation history – Study of deformation textures and structural evolution. 10. Measurement of foliation and lineation orientations – Use of stereographic projections.	10
III	**Fieldwork** 11. Field study in an igneous and metamorphic terrain – • Identification of primary and secondary igneous structures. • Recognition of metamorphic facies, field textures, and structural fabrics. • Sample collection for petrographic and geochemical analysis.	10
Total Notional Credit Hours		**30**

Text Books:

1) Best, M.G. – Igneous and Metamorphic Petrology
2) Philpotts & Ague – Principles of Igneous and Metamorphic Petrology

Reference Books:

1) Winter, J.D. – Principles of Igneous and Metamorphic Petrology
2) Turner, F.J. – Metamorphic Petrology
3) Yardley, B.W.D. – Introduction to Metamorphic Petrology
4) Rollinson, H. – Using Geochemical Data: Evaluation, Presentation, Interpretation

Course Level: 500	SEDIMENTOLOGY AND QUATERNARY GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C107

Course Objective: To equip students with an in-depth understanding of sedimentary processes, depositional environments, and Quaternary geological changes, enabling them to reconstruct past climates, sea-level fluctuations, and human-environment interactions through applied geoscientific methods.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define sedimentary textures, structures, and classification schemes.	**BT 1**
CO 2	Explain sedimentary rock classification, textures, and structures and their significance in reconstructing depositional environments.	**BT 2**
CO 3	Identify and differentiate various depositional environments using sedimentological and stratigraphic principles.	**BT 3**
CO 4	Analyse sedimentary basins using sequence stratigraphy and facies models.	**BT 4**
CO 5	Evaluate Quaternary geological changes, including glacial-interglacial cycles, climate proxies, and sea-level fluctuations.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Sedimentary Basins** Sedimentary Basins in their plate tectonic environment. Classification of the sedimentary basins and their characteristics. Effects of mantle dynamics. Terrestrial sediments and solute yields. Measurements of erosion rates. Functioning of sediment routing systems.	12
Unit 2	**Depositional Environments & Sequence Stratigraphy** Depositional systems: Continental (fluvial, lacustrine, aeolian), transitional (deltaic, estuarine, coastal), and marine environments. Facies concept & facies models: Walther's Law of Facies Succession. Sequence Stratigraphy: Key concepts, systems tracts, parasequences, and sequence boundaries.	12
Unit 3	**Quaternary Geology & Climate Change** Introduction to Quaternary Period: Time scale and major climate events. Quaternary climates – Milankovitch cycles and climate forcing, eustatic changes. Proxy indicators of paleoclimatic changes - land, ocean and cryosphere (ice core studies). Sea-level fluctuations: Causes, methods of reconstruction, and impact on sedimentation. Palaeosols, loess deposits, and desertification: Indicators of past climate change. Quaternary Stratigraphy – Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Defining the Meghalayan Age: The GSSP, the 4.2 ka Event, Impacts of the Meghalayan Drought, Relevance to Modern Climate Change, The Anthropocene Debate.	10
Unit 4	**Applied Quaternary Geology & Geoarchaeology** Dating methods: Radiocarbon dating, U-series, OSL, Cosmogenic nuclides, Amino acid. Quaternary geomorphology: Responses of geomorphic systems to climate, sea level and tectonics on variable time scales in the Quaternary. Human evolution and environmental changes: Archaeological evidence and climate-human interactions. Geoarchaeology case studies from Indian Sub-continent. Quaternary stratigraphy of India– continental records (fluvial, glacial, aeolian, palaeosols and duricrust); marine records; continental-marine correlation of Quaternary record.	11
	Total	**45**

Text Books:

1) Principles of Sedimentology and Stratigraphy – Sam Boggs Jr.
2) Sedimentology and Stratigraphy – Gary Nichols
3) Sedimentary Rocks – F.J. Pettijohn

Reference Books:

1) Introduction to Sedimentology – S. Sengupta
2) Sedimentary Petrology – Maurice E. Tucker
3) Depositional Sedimentary Environments - Reineck and Singh, (1980), Springer – Verlag.
4) Basin Analysis: Principles and Application to Petroleum Play Assessment – Philip A. Allen & John R. Allen

Course Level: 500	SEDIMENTOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C118

Course Objectives: To equip students with an in-depth understanding of sedimentary processes, depositional environments, and Quaternary geological changes, enabling them to reconstruct past climates, sea-level fluctuations, and human-environment interactions through applied geoscientific methods.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define sedimentary textures, structures, and classification schemes.	**BT 1**
CO 2	Explain sedimentary rock classification, textures, and structures and their significance in reconstructing depositional environments.	**BT 2**
CO 3	Identify and differentiate various depositional environments using sedimentological and stratigraphic principles.	**BT 3**
CO 4	Analyse sedimentary basins using sequence stratigraphy and facies models.	**BT 4**
CO 5	Evaluate Quaternary geological changes, including glacial-interglacial cycles, climate proxies, and sea-level fluctuations.	**BT 5**

Modules	Topics and Course Content	Hours
I	**Facies description and interpretation from hand specimens** • Identification of sedimentary textures, grain types, structures, and matrix/cement. **Preparation of Lithologs and Facies Analysis** • Construction of lithologs from vertical sedimentary sections. • Interpretation of facies variations and depositional sequences. **Interpretation of depositional processes based on structures** • Flow regime, palaeocurrent direction, sediment transport mode. **Plotting palaeocurrent data** • Rose diagram preparation and interpretation using unidirectional and bidirectional flow data. **Grain-size analysis and provenance clues** • Sphericity, roundness, grain composition (clastic vs. non-clastic indicators). **Classification of sedimentary basins from tectonic maps and cross-sections** • Examples: rift basins, foreland basins, passive margins, strike-slip basins. **Interpretation of basin evolution** • Using stratigraphic cross-sections and isopach maps. **Identification of key surfaces and systems tracts from stratigraphic columns** • Sequence boundaries, flooding surfaces, maximum flooding surfaces, and parasequences. **Heavy Mineral Separation and Microscopic Study** • Separation techniques (gravity separation, bromoform method, etc.). • Identification of common heavy minerals and their provenance significance.	30
Total Notional Credit Hours		**30**

Text Books:

1) Principles of Sedimentology and Stratigraphy – Sam Boggs Jr.
2) Sedimentology and Stratigraphy – Gary Nichols
3) Sedimentary Rocks – F.J. Pettijohn

Reference Books:

1) Introduction to Sedimentology – S. Sengupta
2) Sedimentary Petrology – Maurice E. Tucker
3) Depositional Sedimentary Environments - Reineck and Singh, (1980), Springer – Verlag.
4) Basin Analysis: Principles and Application to Petroleum Play Assessment – Philip A. Allen & John R. Allen

Course Level: 400	CLIMATOLOGY AND OCEANOGRAPHY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C109

Course Objective: To provide an understanding of the Earth's climate system, atmospheric dynamics, oceanic circulation, and their interactions, with a focus on their geological significance and relevance to climate change.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define key atmospheric and oceanographic concepts, terminologies, and classification systems.	**BT 1**
CO 2	Understand the interactions between the atmosphere, hydrosphere, and lithosphere in climate regulation.	**BT 2**
CO 3	Apply climatic and oceanographic data to interpret weather patterns, ocean circulation, and climate variability.	**BT 3**
CO 4	Analyse the causes and consequences of climate change using historical and modern datasets.	**BT 4**
CO 5	Evaluate the impact of human activities on climate and oceanic systems and propose sustainable solutions.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Climatology** Structure and chemical composition of the atmosphere, lapse rate and stability Solar radiation and Earth's energy budget Atmospheric temperature, pressure, and humidity distribution Cloud formation and precipitation processes Winds and general circulation patterns Jet streams and monsoonal systems w.r.t. to Indian Sub-continent Western disturbances and severe local convective systems Climatic zones and classification (Köppen & Thornthwaite)	15
Unit 2	**Atmospheric Dynamics and Climate Change** Atmospheric turbulence and boundary layer. Atmospheric stability and weather disturbances (cyclones, anticyclones, tornadoes) El Niño, La Niña, and Southern Oscillation (ENSO), Indian Ocean Dipole. Greenhouse effect and global warming Climatic and sea level changes on different time scales. Ice ages and Milankovitch cycles Climate modelling and prediction	15
Unit 3	**Oceanography and Ocean Circulation** Origin and evolution of oceans Physical and chemical properties of seawater (temperature, salinity, density) Residence times of elements in sea water. Oceanic circulation: Surface currents, thermohaline circulation, Coriolis effect and Ekman spiral, convergence, divergence and upwelling. Ocean waves and tides: Formation, classification, and effects Ocean-atmosphere interaction and its role in climate regulation Marine sediments and their significance in paleoceanography	15

Unit 4	**Marine Resources and Oceanic Processes** Oceanic productivity and biological zonation Coral reefs and their geological significance Hydrothermal vents and deep-sea ecosystems Marine pollution and its impact on climate Ocean exploration techniques (Remote Sensing, SONAR, Argo floats) Impact of climate change on oceans (sea-level rise, acidification) Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic.	15
	Total	**60**

Text Books:

1) Barry & Chorley – "Atmosphere, Weather and Climate"
2) Pinet – "Invitation to Oceanography"

Reference Books:

1) Critchfield – "General Climatology"
2) Lutgens & Tarbuck – "The Atmosphere: An Introduction to Meteorology"
3) Garrison – "Oceanography: An Invitation to Marine Science"
4) Trenberth – "Climate System Modeling"
5) Glenn & Turekian – "Oceans"
6) IPCC Reports – "Climate Change Assessments"

Detailed Syllabus
Two-Year M.Sc. Programme
Semester 2

Course Level: 400	INDIAN STRATIGRAPHY AND APPLIED PALAEONTOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C201

Course Objective: To develop an understanding of the fossil record, evolutionary trends, and the stratigraphic framework of India, integrating palaeontological and stratigraphic data for geological interpretations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Describe key evolutionary events, mass extinctions, and major fossil groups in Earth's history.	**BT 1**
CO 2	Understand the evolutionary trends of vertebrates, invertebrates, and microfossils and their applications in palaeoenvironmental and biostratigraphic studies.	**BT 2**
CO 3	Apply palaeontological and stratigraphic principles to analyse fossil records and interpret sedimentary sequences in the Indian geological framework.	**BT 3**
CO 4	Analyse lithostratigraphic, biostratigraphic, and palaeontological data to reconstruct past environments and correlate geological formations.	**BT 4**
CO 5	Evaluate the significance of major geological events (e.g., Precambrian-Proterozoic boundary, Cretaceous-Tertiary transition) using palaeontological and stratigraphic evidence.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	Definition and scope of Applied Palaeontology. Fossils as tools for stratigraphic correlation: Biostratigraphy (zones, index fossils, biochronology). Fossils and palaeoenvironmental reconstructions: Palaeoclimatology and palaeoecology. Introduction to Micropalaeontology: Types of microfossils (foraminifera, ostracods, nannofossils, conodonts, radiolaria). Applications in petroleum exploration: palaeobathymetry, age dating, reservoir characterisation.	12
Unit 2	Spores, pollen, dinoflagellates: Stratigraphic and palaeoclimatic significance. Use of palynofossils in coal, petroleum, and groundwater studies. Trace fossils: Types, ichnofacies, and their use in environmental interpretation and sedimentary basin analysis. Gondwana Flora: Stratigraphic correlation, palaeoclimatic implications, economic relevance. Recent advances: Fossil data in climate change studies and basin modelling.	12
Unit 3	**Stratigraphic Framework of India** **Tectonic Framework:** Cratons, mobile belts, and inter-cratonic shear zones of India. **Precambrian Geology:** Proterozoic basins (Cuddapah, Vindhyan, Kurnool), Archaean-Proterozoic boundary, and Precambrian-Cambrian transition. **Phanerozoic Stratigraphy:** Palaeozoic sequences of the Himalayas and marine Palaeozoics in Peninsular India. **Mesozoic Sequences:** Triassic of Spiti, Jurassic of Kutch, Cretaceous formations of Peninsular India. **Cenozoic Stratigraphy:** Deccan Traps and associated infra/intertrappean sequences, Siwalik vertebrates.	10
Unit 4	**Applied Stratigraphy and Field Applications** **Gondwana Sequence of India**: Basin configuration, sedimentation, palaeoclimates, and marine intercalations. Recent trends in classification of Gondwana strata in India. **Cretaceous-Tertiary Boundary**: Significant events and fossil records. **Stratigraphic Correlation**: Use of fossils in biostratigraphic correlation, and palaeoenvironmental reconstructions. **Applied Palaeontology in Exploration**: Fossil-based interpretations for hydrocarbon and mineral exploration.	11
	Total	**45**

Text Books:

1) Raup & Stanley – "Principles of Paleontology"
2) The Making of India – K. S. Valdiya, Macmillan India Pvt. Ltd. (2010)
3) Cratons and Fold Belts of India – Ram. S. Sharma, Springer (2009)

Reference Books:

1) Clarkson – "Invertebrate Palaeontology and Evolution"
2) Invertebrate Paleontology, Shrock and Twenhoefells, CBS publishers
3) Benton & Harper – "Introduction to Paleobiology and the Fossil Record"
4) Geology of India: A Review by N. C. Pant and B. P. Radhakrishna, Springer (2014)
5) Indian Stratigraphy by Srikant Das, Birbal Sahni Institute of Paleobotany (2018)
6) Geology of India by V. P. Dimri, Springer (2020)
7) Geology of India (Vol. 1 & 2) – M. Ramakrishnan & R. Vaidyanadhan, Geological Society of India, Bangalore (2008).
8) Bose, Mazumdar & Sarkar – "Indian Stratigraphy"

Course Level: 400	STRATIGRAPHY AND PALAEONTOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C212

Course Objective: To develop an understanding of the fossil record, evolutionary trends, and the stratigraphic framework of India, integrating palaeontological and stratigraphic data for geological interpretations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Describe key evolutionary events, mass extinctions, and major fossil groups in Earth's history.	**BT 1**
CO 2	Understand the evolutionary trends of vertebrates, invertebrates, and microfossils and their applications in palaeoenvironmental and biostratigraphic studies.	**BT 2**
CO 3	Apply palaeontological and stratigraphic principles to analyse fossil records and interpret sedimentary sequences in the Indian geological framework.	**BT 3**
CO 4	Analyse lithostratigraphic, biostratigraphic, and palaeontological data to reconstruct past environments and correlate geological formations.	**BT 4**
CO 5	Evaluate the significance of major geological events (e.g., Precambrian-Proterozoic boundary, Cretaceous-Tertiary transition) using palaeontological and stratigraphic evidence.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Morphological Study and Identification of Macro Fossils** • Study and identification of important invertebrate fossils: ○ **Trilobites, Brachiopods, Bivalves, Gastropods, Cephalopods, Corals, Echinoderms.** • Morphofunctional interpretation and palaeoecological significance.	12
Unit 2	**Micropalaeontology** • Slide preparation and microscopic study of: ○ **Foraminifera, Ostracods, Radiolaria, Nannofossils, Conodonts.** • Interpretation of ecological preferences and palaeobathymetry. **Palynology** • Microscopic identification of palynofossils (spores, pollen, dinoflagellates).	8
Unit 3	**Stratigraphic Column Preparation** • Preparation and interpretation of lithostratigraphic columns from geological maps or field data. • Identification of key stratigraphic contacts and unconformities. • Delineation of fossil zones and correlation. **Biostratigraphy and Correlation** • Construction of biostratigraphic range charts using fossil assemblages. • Interpretation of **biozones** (range zone, concurrent range, assemblage zone, acme zone). • Stratigraphic correlation using real or simulated fossil datasets.	5
Unit 4	**Indian Stratigraphy (Map-Based Study)** • Stratigraphic map of major Indian geological formations: ○ **Cuddapah, Vindhyan, Kurnool, Spiti, Kutch, Deccan Traps, Gondwana sequences.** **Palaeogeographic and Basin Analysis** • Palaeogeographic map plotting based on fossil and lithological data. • Case study analysis: Gondwana basin, Kutch basin, Cretaceous-Tertiary boundary.	5
	Total	**30**

Text Books:

1) Raup & Stanley – "Principles of Paleontology"
2) The Making of India – K. S. Valdiya, Macmillan India Pvt. Ltd. (2010)
3) Cratons and Fold Belts of India – Ram. S. Sharma, Springer (2009)

Reference Books:

1) Clarkson – "Invertebrate Palaeontology and Evolution"
2) Invertebrate Paleontology, Shrock and Twenhoefells, CBS publishers
3) Benton & Harper – "Introduction to Paleobiology and the Fossil Record"
4) Geology of India: A Review by N. C. Pant and B. P. Radhakrishna, Springer (2014)
5) Indian Stratigraphy by Srikant Das, Birbal Sahni Institute of Paleobotany (2018)
6) Geology of India by V. P. Dimri, Springer (2020)
7) Geology of India (Vol. 1 & 2) – M. Ramakrishnan & R. Vaidyanadhan, Geological Society of India, Bangalore (2008).
8) Bose, Mazumdar & Sarkar – "Indian Stratigraphy"

Course Level: 500	GEOMORPHOLOGY L-T-P-C: 3-0-0-3 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C203

Course Objective: To develop an advanced understanding of geomorphic processes, with a focus on fluvial systems, tectonic influences, and GIS-based spatial analysis for landform evolution and environmental assessment.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and describe fundamental geomorphic processes, landform development, and associated geological factors.	**BT 1**
CO 2	Describe the fundamental geomorphic processes and their role in landform development.	**BT 2**
CO 3	Apply morphometric techniques to analyse drainage basins and river systems.	**BT 3**
CO 4	Analyse and interpret spatial data using GIS and remote sensing for geomorphological studies.	**BT 4**
CO 5	Evaluate the impact of climate and tectonics on landscape evolution using geomorphic indices.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Advanced Concepts in Geomorphology** Tectonic and climatic controls on landscape evolution. Rates of uplift and denudation; interaction between endogenic and exogenic processes. Models of long-term landscape development. Quaternary climate change: glacial/interglacial cycles, Milankovitch hypothesis, climate records in sediments. Sea-level changes and landscape evolution.	12
Unit 2	**Fluvial and Coastal Geomorphology** Channel geometry and drainage patterns; structural control on fluvial systems. River hydrodynamics: processes of erosion, transportation, and deposition. Drainage basin evolution and morphometry; role of lithology and tectonics. GIS and remote sensing applications in fluvial geomorphology: DEM-based watershed analysis, channel migration studies, and floodplain mapping. Coastal geomorphology: shore zone processes, erosional and depositional landforms. Coastal vulnerability assessment using GIS.	12
Unit 3	**Tectonic Geomorphology** Geomorphic markers of active tectonics (e.g., fault scarps, river anomalies). Geomorphic indices of active tectonics (e.g., stream gradient index, hypsometric integral). River response to climate change and tectonics; river terraces and knickpoints. Relationship between tectonics and drainage evolution.	10
Unit 4	**Applied Geomorphology and Modern Techniques** Mass wasting: classification, triggering mechanisms, and hazard assessment. Application of GIS in landform mapping and change detection. Role of geomorphology in natural hazard assessment (landslides, floods). Remote sensing and terrain analysis for landform studies. Application of geomorphic principles in environmental and engineering projects.	11
	Total	**45**

Text Books:

1) Bloom, A.L. – Geomorphology: A Systematic Analysis of Late Cenozoic Landforms (Prentice Hall)
2) Huggett, R.J. – Fundamentals of Geomorphology (Routledge)
3) Obrien, P. & Pike, R. – Geomorphometry: Concepts, Software, Applications (Elsevier)

Reference Books:

1) Summerfield, M.A. – Global Geomorphology (Longman)
2) Thornbury, W.D. – Principles of Geomorphology (Wiley)
3) Kale, V.S., & Gupta, A. – Introduction to Geomorphology (Universities Press)
4) Schumm, S.A. – River Variability and Complexity (Cambridge University Press)
5) Burbank, D.W. & Anderson, R.S. – Tectonic Geomorphology (Blackwell)
6) Bishop, M.P. & Shroder, J.F. – Remote Sensing and GIS for Natural Hazards Assessment (Taylor & Francis)
7) Montgomery, D.R. & Dietrich, W.E. – Topographic Controls on Watershed-Scale Erosion and Deposition

Course Level: 500	GEOMORPHOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C214

Course Objectives: To develop an advanced understanding of geomorphic processes, with a focus on fluvial systems, tectonic influences, and GIS-based spatial analysis for landform evolution and environmental assessment.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and describe fundamental geomorphic processes, landform development, and associated geological factors.	**BT 1**
CO 2	Describe the fundamental geomorphic processes and their role in landform development.	**BT 2**
CO 3	Apply morphometric techniques to analyse drainage basins and river systems.	**BT 3**
CO 4	Analyse and interpret spatial data using GIS and remote sensing for geomorphological studies.	**BT 4**
CO 5	Evaluate the impact of climate and tectonics on landscape evolution using geomorphic indices.	**BT 5**

Modules	Topics and Course Content	Hours
I	**Topographic and Remote Sensing Analysis** Interpretation of landforms using topographical maps, satellite images, and DEMs. Extraction and analysis of watersheds and drainage networks using GIS and remote sensing. Digital Elevation Model (DEM) processing for terrain analysis and slope mapping.	7
II	**Fluvial Geomorphology Exercises** Preparation of longitudinal river profiles using GIS. Calculation of stream length-gradient index, hypsometric integral, and bifurcation ratio. Automated drainage basin delineation using GIS. Mapping and analysing river meandering, channel migration, and floodplain changes using time-series satellite images. Sediment yield estimation and flood hazard zonation using GIS-based models.	10
III	**Tectonic Geomorphology** Application of geomorphic indices (e.g., mountain-front sinuosity, valley floor width-to-height ratio) using GIS. Mapping and quantifying active faulting and neotectonic deformation using remote sensing techniques.	6
IV	**Coastal Geomorphology** Coastal landform mapping and shoreline change analysis using multi-temporal satellite data. **Applied Geomorphology** Landslide susceptibility mapping using GIS-based models (e.g., AHP, Frequency Ratio). Soil erosion modelling using GIS-based RUSLE (Revised Universal Soil Loss Equation). Geomorphological hazard zonation integrating remote sensing and field-based data.	7
Total Notional Credit Hours		**30**

Text Books:

1) Bloom, A.L. – Geomorphology: A Systematic Analysis of Late Cenozoic Landforms (Prentice Hall)
2) Huggett, R.J. – Fundamentals of Geomorphology (Routledge)
3) Obrien, P. & Pike, R. – Geomorphometry: Concepts, Software, Applications (Elsevier)

Reference Books:

1) Summerfield, M.A. – Global Geomorphology (Longman)
2) Thornbury, W.D. – Principles of Geomorphology (Wiley)
3) Kale, V.S., & Gupta, A. – Introduction to Geomorphology (Universities Press)
4) Schumm, S.A. – River Variability and Complexity (Cambridge University Press)
5) Burbank, D.W. & Anderson, R.S. – Tectonic Geomorphology (Blackwell)
6) Bishop, M.P. & Shroder, J.F. – Remote Sensing and GIS for Natural Hazards Assessment (Taylor & Francis)

Course Level: 400	GEOLOGY OF NORTHEAST INDIA L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C205

Course Objective: To provide a detailed understanding of the geological framework, tectonics, stratigraphy, structural geology, mineral resources, and natural hazards of Northeast India, integrating recent research and advancements.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall the major lithostratigraphic units, structural features, and mineral resources of Northeast India.	**BT 1**
CO 2	Understand the tectonic evolution and stratigraphic framework of the region in relation to plate tectonics and basin development.	**BT 2**
CO 3	Interpret geological maps, seismic data, and remote sensing information to assess geological hazards and resource potential.	**BT 3**
CO 4	Analyse the impact of tectonics, climate, and human activities on the geological processes of Northeast India.	**BT 4**
CO 5	Assess the economic potential of mineral and hydrocarbon resources and their sustainable utilization.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Tectonic and Structural Framework** Geographical and geological setting of Northeast India Tectonic domains: Shillong Plateau, Indo-Myanmar Orogenic Belt, Eastern Himalayan Syntaxis, Bengal Basin Evolution of the Indian Plate and its interaction with the Eurasian and Burmese plates Seismicity and active tectonics: fault systems, earthquake zones, and paleoseismic studies Geodynamic evolution of the Himalayas, Indo-Burma Ranges, and Assam-Arakan Basin	15
Unit 2	**Stratigraphy and Palaeontology** Precambrian formations: Shillong Group, Gneissic Complex, and associated lithounits Gondwana formations of Northeast India: stratigraphy, sedimentation, and palaeoclimate Mesozoic sequences: Cretaceous-Tertiary boundary and associated intrusions (Sylhet Traps, Abor volcanics, Lichi volcanics), Ultramafic complexes of NE India (Sung, Samchampi, etc.). Cenozoic stratigraphy of the Assam-Arakan Basin. Palaeontology of Northeast India: Characteristic Flora, Fauna and Microfossils (including spores and pollens).	15
Unit 3	**Economic Geology and Hydrocarbon Resources** Mineral resources: coal, limestone, petroleum, uranium, graphite, vanadium, and rare earth elements Oil and gas fields of NE India Coal deposits of NE India Uranium occurrences in Meghalaya and associated radioactive mineralization Hot springs and their geothermal Potential in Northeast India	15
Unit 4	**Geomorphology, Environmental Geology, and Hazards** Geomorphology of the Brahmaputra Valley Drainage characteristics of Brahmaputra, Barak, Subansiri, Lohit River systems Geohazards: seismic hazards, Floods and landslides in Northeast India Case study on major earthquake events of 1897 and 1950 in Northeast India Soil erosion in Northeast India Environmental impact of mining and hydroelectric projects in the region	15
	Total	**60**

Text Books:

1) Krishnan, M.S. (2017) – Geology of India and Burma, CBS Publishers.
2) Valdiya, K.S. (2016) – Himalayan Geology, Springer.
3) Banerjee, A. (2015) – Tectonics of the Eastern Himalayas and Indo-Myanmar Orogenic Belt, Cambridge Scholars Publishing.

Reference Materials:

1) Geological Survey of India (GSI) Memoirs and Publications on Northeast India, Various editions. (Reports & Books)
2) Jain, A.K. & Manickavasagam, R.M. (2018) – Geology of the Himalayas and Northeast India, Elsevier. (Book)
3) Acharyya, S.K. (2007) – Tectonic Framework and Evolution of the Eastern Himalayas and Indo-Burma Orogen, Journal of Asian Earth Sciences, 29(2), 219–233. (Research Paper)
4) Murthy, K.S.R. et al. (2012) – Petroleum Geology of the Assam-Arakan Basin, Journal of Petroleum Geology, 35(4), 321–340. (Research Paper)
5) Rai, S. et al. (2020) – Seismotectonics of Northeast India: Recent Advances, Tectonophysics, 796, 228–245. (Research Paper)

Course Level: 400	PLANETARY GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C206

Course Objective: To develop an understanding of the geological processes shaping planetary bodies, the evolution of the Solar System, and the application of remote sensing and astrobiology in planetary exploration.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall key concepts related to planetary formation, surface processes, and geological evolution of Solar System bodies.	**BT 1**
CO 2	Explain the geological features and atmospheric evolution of terrestrial planets, moons, and asteroids.	**BT 2**
CO 3	Apply remote sensing and crater dating methods to interpret planetary surface processes.	**BT 3**
CO 4	Compare planetary environments to assess habitability and geological activity.	**BT 4**
CO 5	Evaluate the feasibility of space resource utilisation and human exploration strategies.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Origin and Evolution of the Solar System** The formation and differentiation of planetary bodies. Origin of elements, planetary accretion, and core formation. Methods of Solar System exploration: space missions, remote sensing, sample return missions. Meteorites, asteroids, and comets as records of early Solar System processes. Giant impacts and planetary evolution (e.g., Earth-Moon system formation). Dating planetary surfaces using crater analysis and radiometric methods.	15
Unit 2	**Comparative Planetary Geology** Thermal evolution of planets and moons: influence of planetary size and composition. Planetary atmospheres: evolution, retention, and climate history. Surface and internal geology of terrestrial planets: **Mercury:** Tectonics, volcanism, and magnetic field. **Venus:** Surface weathering, volcanism, and atmospheric dynamics. **Moon:** Regolith formation, impact cratering, and volcanic plains. **Mars:** Volcanism (Tharsis region), fluvial and glacial geomorphology, dust storms. Geological and geophysical properties of major moons (e.g., Europa, Titan, Ganymede). Giant planets and their satellites: structure, atmospheres, and magnetospheres.	15
Unit 3	**Planetary Surface Processes & Remote Sensing Applications** Impact cratering: formation stages, ejecta distribution, and shock metamorphism. Volcanism on terrestrial planets and icy moons (e.g., cryovolcanism on Enceladus). Aeolian, fluvial, and glacial processes on Mars and Titan. Remote sensing techniques in planetary geology: multispectral imaging, radar, LIDAR. Data analysis from space missions (Lunar Reconnaissance Orbiter, Mangalyaan, Perseverance) Applications of GIS and machine learning in planetary surface mapping.	15
Unit 4	**Astrobiology and Planetary Exploration** Habitability criteria in the Solar System: liquid water, energy sources, and organic molecules. Biosignatures and life-detection strategies on Mars, Europa, and Enceladus. Exoplanetary geology: Earth-like planets and their geological potential. Terraforming Mars: scientific feasibility and challenges. Future planetary exploration missions and their scientific objectives (e.g., Artemis, Dragonfly). Space resources: mining asteroids and lunar regolith for sustainable space exploration.	15
	Total	**60**

Text Books:

1) The New Solar System – Beatty, Petersen, Chaikin (5th Ed., 1999)
2) Planetary Geology – Greeley & Batson (1990)
3) Comparative Planetology, Geological Perspectives – Ronald Greeley (1985)

Reference Materials:

1) Meteorites and Their Parent Planets – Harry Y. McSween (2nd Ed., 1999, Book)
2) Solar System Evolution: A New Perspective – Stuart Ross Taylor (2nd Ed., 2001, Book)
3) Astrobiology: A Very Short Introduction – David Catling (2013, Book)
4) Evidence for Water on Mars – Malin & Edgett (Science, 2000, Paper)
5) Impact Cratering as a Geological Process – Melosh (1989, Paper)
6) Planetary Science: The Science of Planets Around Stars – de Pater & Lissauer (2015, Book)
7) NASA Technical Reports on Planetary Geology and Remote Sensing (Various Years, Reports)

Course Level: 400	URBAN GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C207

Course Objective: To develop an understanding of geological processes in urban environments and equip students with the knowledge and skills to assess geological hazards, manage urban resources, and apply geotechnical and GIS-based solutions for sustainable urban development.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Define and explain fundamental concepts of urban geology, including geological factors influencing urbanisation and sustainability.	**BT 1**
CO 2	Describe and analyse various geohazards such as earthquakes, landslides, and subsidence, and assess their impact on urban areas.	**BT 2**
CO 3	Apply geological principles in geotechnical investigations, land-use planning, and hazard mitigation strategies.	**BT 3**
CO 4	Analyse groundwater resources, urban mineral resources, and environmental concerns to develop sustainable management strategies.	**BT 4**
CO 5	Evaluate geological risks using GIS and remote sensing techniques for hazard assessment and urban planning.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Urban Geology** Definition, scope, and significance of Urban Geology Geological factors influencing urban development and sustainability Subsurface geological characterisation in urban areas Soil mechanics and foundation engineering for construction Geological materials in urban infrastructure development	15
Unit 2	**Geohazards and Risk Assessment in Urban Areas** Geological hazards: Earthquakes, landslides, floods, subsidence, sinkholes Urban flood risk assessment and mitigation strategies Engineering solutions for urban landslides and slope stability Seismic microzonation and earthquake-resistant design principles Role of remote sensing and GIS in urban hazard mapping	15
Unit 3	**Urban Resources and Environmental Management** Groundwater resources, aquifer characterisation, and management Urban mineral resources: Quarrying, excavation, and impacts Geothermal energy in cities: Potential, challenges, and applications Urban pollution: Sources, groundwater contamination, and remediation Sustainable urban planning: Environmental impact assessments (EIA)	15
Unit 4	**Applied Urban Geology and GIS Applications** Geology-based urban planning and land-use zoning Geological aesthetics and urban greenspace development Use of GIS and remote sensing in urban geology studies Case studies of geological hazards in urban environments Policies and regulations for urban geological sustainability	15
	Total	**60**

Text Books:

1) Bell, F. G. (2004). Engineering Geology and Construction. CRC Press.
2) McCall, G. J. H., Marker, B. R. & Laming, D. J. C. (2004). Urban Geology in Land Use Planning. Geological Society of London.

Reference Materials:

1) Keller, E. A. & DeVecchio, D. E. (2019). Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. Routledge.
2) Goudie, A. (2018). Human Impact on the Natural Environment: Past, Present, and Future. Wiley-Blackwell.
3) Yan, J. & Edwards, P. (2019). GIS and Geostatistical Techniques for Groundwater Science. Elsevier.
4) Rivas, V. & Horacio, D. (2014). Urban Geology in Latin America. Springer.
5) van Westen, C. J. (2000). GIS in Natural Hazard Assessment. ITC Journal, 2(3), 45-58. [Paper]
6) Brunsden, D. (1993). The Role of Geomorphology in Urban Planning and Hazard Assessment. Geological Society Special Publications, 14, 63-75. [Paper]

Detailed Syllabus
Two-Year M.Sc. Programme
Semester 3

Course Level: 500	ENGINEERING GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C301

Course Objective: To equip students with the principles of engineering geology and geotechnical investigation, focusing on soil and rock mechanics, slope stability, and the geological considerations essential for infrastructure development.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of soil mechanics, rock properties, and geological factors influencing engineering projects.	**BT 1**
CO 2	Understand the fundamental concepts of soil and rock mechanics and their applications in geotechnical engineering.	**BT 2**
CO 3	Apply geological principles in site selection, foundation analysis, and stability assessment of dams, tunnels, and slopes.	**BT 3**
CO 4	Analyse the impact of geological structures and material properties on infrastructure stability and hazard mitigation.	**BT 4**
CO 5	Evaluate engineering problems related to slope stability, tunnel construction, and dam safety using geotechnical investigation methods and GIS-based tools.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Soil and Rock Mechanics** Soil: Engineering properties, unit weight, specific gravity, porosity, void ratio, water content, and degree of saturation. Compressibility, consolidation, compaction, and shear strength of soils. Clay mineralogy and its significance in soil behaviour, Atterberg limits, and soil classification. Engineering properties of rocks: Strength, hardness, elasticity, porosity, and specific gravity. Rock masses: Discontinuities, weathering, and deformation. Engineering classification of rocks and rock masses (RQD, Bieniawski's RMR, Q-system).	12
Unit 2	**Ground Improvement Techniques** Rock mass improvement techniques: Grouting, bolting, anchoring, and shotcreting. Quarrying and rock blasting techniques. Use of rocks as construction materials. Geotechnical properties of aggregates used in construction.	12
Unit 3	**Dams and Reservoirs** Types of engineering geological investigations: Preliminary and Detailed Types and classification of dams. Geological and geophysical investigations for dam foundations and abutments. Foundation and abutment problems: Seepage, bearing strength, and rebound problems. Treatment of weak zones: Grouting, anchoring and rock bolting. Reservoir area investigations, leakage control, and sedimentation issues. Problems associated with earth dams and embankments. Case studies of Subansiri Lower Hydroelectric Project (SLHEP), Arunachal Pradesh/Assam and Teesta III Hydroelectric Project, Sikkim.	11
Unit 4	**Tunnels, Bridges, and Slope Stability** Geotechnical investigations for tunnel construction: Site selection, geological considerations, groundwater influence, and rock stress conditions. Tunnel excavation methods and support systems. Role of geological discontinuities in tunnel and bridge alignment. Landslide hazard zonation and slope stability analysis. Engineering solutions for slope stability problems using GIS and remote sensing.	10
	Total	**45**

Text Books:

1) Bell, F.G. (2007). Engineering Geology. Elsevier.
2) Krynine, D.P., & Judd, W.R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.

Reference Books:

1) Hobbs, W.R., & Waltham, T. (2002). Foundations of Engineering Geology. Routledge.
2) West, T.R. (2004). Geology Applied to Engineering. Waveland Press.
3) Das, B.M. (2011). Principles of Geotechnical Engineering. Cengage Learning.
4) Goodman, R.E. (1993). Engineering Geology: Rock in Engineering Construction. John Wiley & Sons.

Course Level: 500	ENGINEERING GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C312

Course Objective: To equip students with the principles of engineering geology and geotechnical investigation, focusing on soil and rock mechanics, slope stability, and the geological considerations essential for infrastructure development.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of soil mechanics, rock properties, and geological factors influencing engineering projects.	**BT 1**
CO 2	Understand the fundamental concepts of soil and rock mechanics and their applications in geotechnical engineering.	**BT 2**
CO 3	Apply geological principles in site selection, foundation analysis, and stability assessment of dams, tunnels, and slopes.	**BT 3**
CO 4	Analyse the impact of geological structures and material properties on infrastructure stability and hazard mitigation.	**BT 4**
CO 5	Evaluate engineering problems related to slope stability, tunnel construction, and dam safety using geotechnical investigation methods and GIS-based tools.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	Computation of reservoir area, catchment area, reservoir capacity, and reservoir life. Analysis of geological cross-sections for infrastructure projects. Computation of index properties of soils. Determination of RQD, RMR, and Q-values. Shear strength analysis of rocks and soils. Determination of strength of rock mass by GSI (Geological Strength Index) method and uniaxial compressive strength of rocks. GIS-based analysis of slope stability and landslide hazard zonation. Numerical and graphical analysis of geotechnical stability problems (Markland's Test)	30
	Total	**30**

Text Books:

1) Bell, F.G. (2007). Engineering Geology. Elsevier.
2) Krynine, D.P., & Judd, W.R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.

Reference Books:

1) Hobbs, W.R., & Waltham, T. (2002). Foundations of Engineering Geology. Routledge.
2) West, T.R. (2004). Geology Applied to Engineering. Waveland Press.
3) Das, B.M. (2011). Principles of Geotechnical Engineering. Cengage Learning.
4) Goodman, R.E. (1993). Engineering Geology: Rock in Engineering Construction. John Wiley & Sons.

Course Level: 500	ECONOMIC GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C303

Course Objective: To provide a comprehensive understanding of the genesis, classification, and economic significance of ore deposits, along with modern mineral exploration techniques and sustainable resource management.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall the fundamental concepts of ore genesis, classification, and economic significance of mineral deposits using basic scientific principles.	**BT 1**
CO 2	Understand the fundamental processes of ore formation and classification of ore deposits.	**BT 2**
CO 3	Apply geophysical, geochemical, and remote sensing techniques for mineral exploration.	**BT 3**
CO 4	Analyse the structural and geochemical controls governing ore deposition.	**BT 4**
CO 5	Evaluate the distribution, mineralogy, and genesis of major mineral resources in India, including those in North-East India.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Ore Genesis and Ore Deposits** Morphology, textural and structural features of ore bodies. Classification of ore deposits: Genetic and descriptive classification. Ore-forming processes: Magmatic, hydrothermal, sedimentary, metamorphic, contact metasomatic, pegmatitic, oxidation and supergene enrichment. SEDEX and VMS deposits, Placer deposits, Laterites. Role of tectonics in ore deposit formation: Metallogeny and crustal evolution. Metallogeny of Archaean greenstone belts and Proterozoic mobile belts.	12
Unit 2	**Structural and Chemical Controls on Ore Formation** Structural controls: Faults, folds, shear zones, unconformities, intrusions. Chemical controls: pH, redox potential, ligand complexing in ore formation. Geochemistry of ore-forming fluids: Stable and radiogenic isotopes in mineral exploration. Application of fluid inclusion studies in ore genesis.	12
Unit 3	**Mineral Resources of India** Distribution, mode of occurrence, mineralogy, and genesis of major mineral deposits in India: • **Critical Minerals**: Nickel, titanium, vanadium, tungsten, chromium, PGE, copper, graphite, manganese, molybdenum, lithium, and REE. • **Strategic Minerals**: Sulphur, lead, petroleum, zinc, mercury, platinum, nickel, graphite, tin, ferro-tungsten. • **Essential Minerals**: Iron ore, manganese, chromite, copper, gold, bauxite, coal, limestone, mica, gypsum, natural gas, thorium, uranium. Introduction to industrial minerals and their economic importance. Gemstones: Occurrence, economic value, and processing techniques.	11
Unit 4	**Applied Economic Geology** Strategic importance of minerals and resource security. Environmental and social impact of mineral extraction and mining sustainability. Introduction to National Mineral Exploration Trust (NMET), National Exploration Policy (NEP), National Critical Mineral Mission (NCMM). Role of GIS in mineral resource mapping and exploration. Economic minerals of **North-East India**: Critical, strategic, and essential minerals, with emphasis on petroleum, coal, bauxite, limestone, vanadium, REE, and uranium.	10
	Total	**45**

Text Books:

1) Evans, A. M. (1993) – Ore Geology and Industrial Minerals, Blackwell Science.
2) Mookherjee, A. (2000) – Ore Genesis: A Holistic Approach, Allied Publishers.

Reference Books:

1) Guilbert, J. M., & Park, C. F. Jr. (1986) – The Geology of Ore Deposits, Freeman.
2) Dutta, S. (2014) – Economic Geology: Economic Mineral Deposits, CBS Publishers.
3) Craig, J. R., Vaughan, D. J., & Skinner, B. J. (2011) – Resources of the Earth: Origin, Use, and Environmental Impact, Pearson.
4) Robb, L. J. (2005) – Introduction to Ore-Forming Processes, Wiley-Blackwell.
5) Deb, M. & Goodfellow, W. D. (2004) – Sediment-Hosted Lead-Zinc Sulphide Deposits: Attributes and Models of Some Major Deposits in India and Canada, Elsevier.
6) Geological Survey of India (GSI) Publications – Reports on Mineral Deposits in India.

Course Level: 500	ECONOMIC GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C314

Course Objective: To provide a comprehensive understanding of the genesis, classification, and economic significance of ore deposits, along with modern mineral exploration techniques and sustainable resource management.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall the fundamental concepts of ore genesis, classification, and economic significance of mineral deposits using basic scientific principles.	**BT 1**
CO 2	Understand the fundamental processes of ore formation and classification of ore deposits.	**BT 2**
CO 3	Apply geophysical, geochemical, and remote sensing techniques for mineral exploration.	**BT 3**
CO 4	Analyse the structural and geochemical controls governing ore deposition.	**BT 4**
CO 5	Evaluate the distribution, mineralogy, and genesis of major mineral resources in India, including those in North-East India.	**BT 5**

Modules	Topics and Course Content	Hours

Unit 1	**Megascopic Identification of Ore and Industrial Minerals**
	• Physical properties (lustre, streak, hardness, density, cleavage, colour, etc.)
	• Identification of:
	  o **Metallic ores**: Hematite, magnetite, chalcopyrite, galena, sphalerite, pyrolusite, chromite, malachite, bauxite.
	  o **Industrial minerals**: Barite, fluorite, gypsum, mica, talc, graphite, kyanite, quartz, feldspar.
	Ore Microscopy (Under Reflected Light)
	• Introduction to reflected light microscopy.
	• Textural identification: granular, colloform, intergrowths, cataclastic, replacement textures.
	• Microscopic study and description of:
	  o **Sulphide ores**: Chalcopyrite, pyrite, galena, sphalerite, bornite.
	  o **Oxide ores**: Hematite, magnetite, cassiterite, chromite, ilmenite.
	• Interpretation of ore textures in relation to ore genesis.
		10

Unit 2	**Preparation and Description of Paragenetic Sequences**
	• Drawing paragenetic sequence diagrams from given case studies.
	• Interpretation of ore-forming environments based on textural and mineralogical relationships.
	Map and Cross-section Based Practical
	• Interpretation of geological maps showing:
	  o Structural controls on ore deposits (faults, folds, unconformities).
	  o Ore body geometry and zoning patterns.
	• Location and marking of major **mineral belts and basins** on:
	  o **Indian Geological Map**: Singhbhum, Aravalli, Dharwar, Bastar, North-East India.
		7

Unit 3	**Practical on Mineral Exploration Techniques** • Overview of sampling methods (stream sediment, soil, trench, borehole). • Introduction to **fluid inclusion diagrams** and their geological interpretation. • Basics of **geochemical data interpretation** for exploration. • Study of **GIS-based mineral resource maps** (GSI/Bhuvan demo datasets or static images).	8
Unit 4	**Gemstone Identification and Properties** • Physical identification of important gemstones: garnet, beryl, corundum, quartz varieties (amethyst, citrine), topaz. • Study of gemstone enhancement and valuation basics.	5
	Total	**30**

Text Books:

1) Evans, A. M. (1993) – Ore Geology and Industrial Minerals, Blackwell Science.
2) Mookherjee, A. (2000) – Ore Genesis: A Holistic Approach, Allied Publishers.

Reference Books:

1) Guilbert, J. M., & Park, C. F. Jr. (1986) – The Geology of Ore Deposits, Freeman.
2) Dutta, S. (2014) – Economic Geology: Economic Mineral Deposits, CBS Publishers.
3) Craig, J. R., Vaughan, D. J., & Skinner, B. J. (2011) – Resources of the Earth: Origin, Use, and Environmental Impact, Pearson.
4) Robb, L. J. (2005) – Introduction to Ore-Forming Processes, Wiley-Blackwell.
5) Deb, M. & Goodfellow, W. D. (2004) – Sediment-Hosted Lead-Zinc Sulphide Deposits: Attributes and Models of Some Major Deposits in India and Canada, Elsevier.
6) Geological Survey of India (GSI) Publications – Reports on Mineral Deposits in India.

Course Level: 500	FUEL GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C305

Course Objective: To provide students with a comprehensive understanding of the origin, classification, exploration, and economic significance of coal, petroleum, and natural gas, with a focus on their geological characteristics, distribution, and environmental considerations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define the fundamental concepts related to the origin, classification, and properties of coal and petroleum.	**BT 1**
CO 2	Understand the processes of coalification, petroleum formation, migration, accumulation, and trapping mechanisms.	**BT 2**
CO 3	Apply coal and petroleum classification systems, analytical techniques, and petrographic methods to assess fuel resources.	**BT 3**
CO 4	Analyse geological, geochemical, and structural factors influencing the occurrence and distribution of coal and petroleum reserves.	**BT 4**
CO 5	Evaluate the economic significance, industrial applications, and environmental impact of fossil fuel exploration and extraction.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Origin and Formation of Coal** Coal forming processes. Climatic, paleogeographic, and tectonic conditions for peat swamp development. Sedimentation of coal-bearing sequences and geological features of coal seams. Diagenesis of peat, coalification processes, and changes in coal properties. Causes of coalification and classification of coal ranks.	12
Unit 2	**Coal Analysis, Petrography, and Indian Coal Deposits** Coal sampling and analysis: proximate and ultimate analysis. Physical and chemical properties of coal, trace elements, and environmental concerns. Coal petrography: macroscopic and microscopic properties, maceral classification, microlithotypes. Classification and industrial applications of coal. Geological and geographical distribution of Indian coal deposits, with a focus on NE India.	12
Unit 3	**Origin and Characteristics of Petroleum** Basic components of petroleum and its physical properties. Theories of petroleum origin: organic and inorganic theories. Source rock definition, types, and transformation processes (diagenesis, catagenesis, metagenesis). Characteristics of source rocks, reservoir rocks, and cap rocks. Types of reservoir rocks: clastic, carbonate, fractured, marine, and non-marine reservoirs.	11
Unit 4	**Hydrocarbon Migration, Accumulation, and Indian Oil and Gas Fields** Hydrocarbon migration: primary and secondary migration mechanisms. Classification of hydrocarbon traps: structural, stratigraphic, and combination types. Classification of petroliferous basins of India. Major oil and gas fields of India: Assam, Arunachal Pradesh, Nagaland, Tripura, Mizoram, Cambay Basin, Bombay Offshore, Krishna-Godavari Basin. Environmental impact of hydrocarbon exploration and extraction. Concept of Green Energy and Net Zero Goals.	10
	Total	**45**

Text Books:

1) Thomas, L. (2020). Coal Geology (3rd Edition). Wiley-Blackwell.
2) Tissot, B. P., & Welte, D. H. (1984). Petroleum Formation and Occurrence. Springer.

Reference Books:

1) Singh, R. M. (1997). Coal and Organic Petrology. Hindustan Publishing Corporation.
2) Stach, E., Taylor, G. H., Mackowsky, M. T., Teichmüller, M., & Chandra, D. (1982). Stach's Textbook of Coal Petrology. Gebrüder Borntraeger.
3) Diessel, C. F. K. (1992). Coal-bearing Depositional Systems. Springer.
4) North, F. K. (1985). Petroleum Geology. Allen & Unwin.
5) Doust, H., & Chapman, M. (2018). Hydrocarbon Exploration & Production. Elsevier.
6) Allen, P. A., & Allen, J. R. (2013). Basin Analysis: Principles and Application to Petroleum Play Assessment. Wiley-Blackwell.

Course Level: 500	FUEL GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C316

Course Objective: To provide students with a comprehensive understanding of the origin, classification, exploration, and economic significance of coal, petroleum, and natural gas, with a focus on their geological characteristics, distribution, and environmental considerations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define the fundamental concepts related to the origin, classification, and properties of coal and petroleum.	**BT 1**
CO 2	Understand the processes of coalification, petroleum formation, migration, accumulation, and trapping mechanisms.	**BT 2**
CO 3	Apply coal and petroleum classification systems, analytical techniques, and petrographic methods to assess fuel resources.	**BT 3**
CO 4	Analyse geological, geochemical, and structural factors influencing the occurrence and distribution of coal and petroleum reserves.	**BT 4**
CO 5	Evaluate the economic significance, industrial applications, and environmental impact of fossil fuel exploration and extraction.	**BT 5**

Modules	Topics and Course Content	Hours

Unit 1	**Megascopic Study of Coal Samples**
	• Identification of coal types based on:
	  ○ Colour, lustre, hardness, streak, and breakage.
	  ○ Recognition of **coal ranks**: lignite, sub-bituminous, bituminous, and anthracite.
	• Recording physical and structural features of coal (cleat, banding, parting, mineral matter).
	Proximate Analysis of Coal
	• Demonstration or interpretation of laboratory data to determine:
	  ○ **Moisture content**
	  ○ **Volatile matter**
	  ○ **Ash content**
	  ○ **Fixed carbon**
	• Interpretation of results to assess coal quality for industrial applications.
	Microscopic Petrography of Coal (Vitrinite Reflectance + Maceral Study)
	• Identification of macerals under reflected light microscope:
	  ○ **Vitrinite group** (telinite, collinite)
	  ○ **Liptinite group** (sporinite, cutinite)
	  ○ **Inertinite group** (fusinite, semifusinite)
	• Classification of **microlithotypes**: vitrite, clarite, durite, fusite, etc.
	• Estimation of vitrinite reflectance and its use in determining **coal rank**.
	Coal Deposit Mapping – Indian Context
	• Study and interpretation of **coal distribution maps** of India.
	• Marking major **coalfields**: Jharia, Raniganj, Bokaro, Talcher, Singrauli, Makum, Namchik-Namphuk (Arunachal), Tikak (Assam), etc.
	• Preparation of stratigraphic columns showing coal-bearing horizons in India.
		15

Unit 2	**Study of Indian Petroleum Fields (Map Work)**
	• Plotting major **oil and gas fields of India**:
	  o Assam-Arakan Basin, Bombay High, Krishna-Godavari Basin, Cambay Basin, Cauvery Basin, Rajasthan Basin.
	• Classification of **petroliferous basins** based on tectonic setting (per DGH/ONGC classification).
	Interpretation of Hydrocarbon Traps (Block Diagrams / Sections)
	• Study and sketching of models:
	  o **Structural traps**: anticline, fault traps, domes.
	  o **Stratigraphic traps**: pinch-out, unconformity traps.
	  o **Combination traps**: faulted anticlines.
	• Case examples from Indian basins.
	Study of Wireline Logs (Demo/Simulated Logs)
	• Introduction to **SP (Spontaneous Potential)** and **Resistivity Logs**.
	• Interpretation of hydrocarbon zones using log responses.
	• Simple exercises to identify reservoir and water zones.
	Interpretation of structure contour maps and isopach maps.
	Reserve estimation and calculation for coal and petroleum deposits.
		15

	Total	**30**

Text Books:

1) Thomas, L. (2020). Coal Geology (3rd Edition). Wiley-Blackwell.
2) Tissot, B. P., & Welte, D. H. (1984). Petroleum Formation and Occurrence. Springer.

Reference Books:

1) Singh, R. M. (1997). Coal and Organic Petrology. Hindustan Publishing Corporation.
2) Stach, E., Taylor, G. H., Mackowsky, M. T., Teichmüller, M., & Chandra, D. (1982). Stach's Textbook of Coal Petrology. Gebrüder Borntraeger.
3) Diessel, C. F. K. (1992). Coal-bearing Depositional Systems. Springer.
4) North, F. K. (1985). Petroleum Geology. Allen & Unwin.
5) Doust, H., & Chapman, M. (2018). Hydrocarbon Exploration & Production. Elsevier.
6) Allen, P. A., & Allen, J. R. (2013). Basin Analysis: Principles and Application to Petroleum Play Assessment. Wiley-Blackwell.

Course Level: Research	Pre-Dissertation Research L-T-P-C: 0-0-0-8 Credits: 8 Scheme of Evaluation: Project	Course Code: GEOL164C327

Course Objective: To enable students to conduct minor-level research by identifying a geoscientific problem, applying appropriate methodologies, and interpreting results systematically, fostering independent thinking and research skills.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Understand the fundamentals of research methodology, scientific writing, and data interpretation in geological studies.	**BT 2**
CO 2	Formulate a research problem, collect and analyse geological data using appropriate field and laboratory techniques.	**BT 3**
CO 3	Interpret geological datasets and present scientific arguments logically and coherently.	**BT 4**
CO 4	Critically assess existing literature and integrate findings to support research conclusions.	**BT 5**
CO 5	Develop a well-structured research report/dissertation and present research findings effectively.	**BT 6**

Sl. No.	Research Outline	Timeline
1	**Introduction to Research & Project Planning** • Fundamentals of research methodology in geosciences • Identifying a research problem and defining objectives • Literature review: sources, citation, and referencing (use of software like Mendeley/Zotero) • Research ethics, plagiarism, and scientific integrity	2 Weeks
2	**Methodology & Data Collection** • Selection of appropriate methods for field/laboratory studies • Techniques in geological mapping, remote sensing, GIS, and geophysical/geochemical analyses • Sampling techniques and data acquisition methods • Use of software for data processing (e.g., QGIS, MATLAB, RockWorks, Surfer, ORIGIN)	5 Weeks
3	**Data Analysis & Interpretation** • Statistical and graphical representation of data • Quantitative and qualitative interpretation of results • Comparing findings with existing literature • Error analysis and uncertainty assessment	4 Weeks
4	**Report Writing & Presentation** • Structure of a research dissertation: Abstract, Introduction, Methodology, Results, Discussion, Conclusion, References • Formatting and writing scientific reports (following university guidelines) • Preparing research posters and PowerPoint presentations • Oral defence and viva-voce examination	4 Weeks
	Total	**15 weeks**

Assessment Criteria:

Component	Marks (%)	Evaluation Criteria
Proposal Submission	10%	Research question, objectives, feasibility
Mid-Term Review	20%	Progress, data collection, preliminary analysis
Final Report	40%	Report quality, analysis, interpretation, presentation
Oral Presentation & Viva	20%	Clarity, content, response to questions
Work Ethics & Engagement	10%	Attendance, effort, interaction with supervisor

Reference Books:

1) Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Age International.
2) Press, F., & Siever, R. (2001). Understanding Earth. W. H. Freeman.
3) Tucker, M. E. (2011). Sedimentary Rocks in the Field: A Practical Guide. Wiley-Blackwell.
4) Compton, R. R. (1985). Geology in the Field. Wiley.
5) Petrie, E. S., & Boggs, S. (2007). Geological Field Techniques. Wiley.
6) Academic papers & journal articles related to the research topic.

Detailed Syllabus
Two-Year M.Sc. Programme
Semester 4

Course Level: 500	EXPLORATION GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C401

Course Objective: To provide a comprehensive understanding of geological, geochemical, geophysical, and remote sensing methods used in mineral and hydrocarbon exploration, while integrating modern techniques, sustainability, and planning stages relevant to contemporary exploration programmes.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Identify and recall fundamental concepts, terminologies, and techniques used in geological, geophysical, and geochemical exploration.	**BT 1**
CO 2	Explain the principles behind different exploration methods and interpret the role of rock properties and surface features in resource identification.	**BT 2**
CO 3	Demonstrate the application of various exploration tools such as geochemical pathfinders, geophysical instruments, and remote sensing data in field or simulated exploration tasks.	**BT 3**
CO 4	Critically analyse subsurface data (e.g., seismic, resistivity, logging) to delineate potential mineral or hydrocarbon-bearing zones.	**BT 4**
CO 5	Assess the effectiveness and limitations of exploration techniques in different geological terrains and evaluate exploration data for feasibility reporting.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals and Planning of Exploration** Scope and importance of exploration geology in mineral and hydrocarbon industries Physical properties of rocks: density, magnetic susceptibility, resistivity, elastic wave velocities Factors influencing rock properties and their relevance to exploration Exploration planning stages: reconnaissance, detailed investigation, feasibility studies Environmental and sustainability concerns during exploration activities	15
Unit 2	**Geological, Geochemical, and Geobotanical Methods** Geological mapping and litho-structural interpretation in exploration Geochemical exploration: surface and subsurface sampling methods, pathfinder elements, data interpretation Geobotanical prospecting: principles, indicator plant species, and practical applications Introduction to geostatistics: sampling strategies, resource/reserve estimation basics	15
Unit 3	**Geophysical Exploration Techniques** Seismic methods: principles of reflection and refraction, seismic tomography Gravity and magnetic methods: instrumentation, survey techniques, data interpretation Electrical methods: resistivity surveys, induced polarisation (IP), self-potential (SP) Remote Sensing & GIS in mineral exploration: multispectral/hyperspectral imaging, spectral analysis for mineral targeting, integration with GIS	15
Unit 4	**Drilling, Logging, and Subsurface Investigations** Drilling techniques: core drilling, rotary drilling, directional drilling – applications and limitations Well logging techniques: SP, GR, resistivity, neutron, density, and sonic logs – interpretation and applications Role of well-site geologists in exploration drilling Surface and subsurface methods of mineral prospecting Introduction to UNFC Stages of Exploration Use of AI/ML in mineral exploration	15
	Total	**60**

Text Books:

1) Moon, C.J., Whateley, M.K.G., & Evans, A.M. (2006) - Introduction to Mineral Exploration (Wiley).
2) Robb, L. (2005) - Introduction to Ore-Forming Processes (Wiley-Blackwell).

Reference Books:

1) Dobrin, M.B. & Savit, C.H. (1988) - Introduction to Geophysical Prospecting (McGraw-Hill).
2) Telford, W.M., Geldart, L.P., & Sheriff, R.E. (1990) - Applied Geophysics (Cambridge University Press).
3) Kearey, P., Brooks, M., & Hill, I. (2002) - An Introduction to Geophysical Exploration (Wiley).
4) Craig, J.R., Vaughan, D.J., & Skinner, B.J. (2011) - Resources of the Earth: Origin, Use, and Environmental Impact (Pearson).
5) Gates, A.E. (2003) - Mining and Its Impact on the Environment (Taylor & Francis).

Course Level: 500	MINING GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C402

Course Objective: This course aims to equip students with comprehensive knowledge and practical understanding of the principles, methods, and applications of mining geology, including ore exploration, sampling, reserve estimation, mining techniques, and environmental and legal considerations associated with mining operations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define fundamental concepts and terminologies related to mining geology, including mining methods, ore sampling, and reserve estimation.	**BT 1**
CO 2	Explain the processes of ore exploration, evaluation, and different mining techniques along with their geological implications.	**BT 2**
CO 3	Apply geological knowledge to identify suitable mining methods and perform basic calculations related to ore reserve estimation.	**BT 3**
CO 4	Analyse geological, structural, and economic factors that influence the selection of mining sites and techniques.	**BT 4**
CO 5	Evaluate the feasibility, efficiency, and environmental implications of various mining operations and plans.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Basic Concepts in Mining Geology** Scope of mining geology: Role of a geologist in mining industry. Life cycle of a mining project: Exploration, feasibility, development, production, and closure. Classification of mineral deposits based on mining methods. Geological, economic, and technological factors influencing mine-development. Drilling techniques: Core and non-core drilling, planning of drilling programmes.	15
Unit 2	**Sampling and Ore Reserve Estimation** Principles and methods of sampling: Channel, chip, grab, bulk sampling. Sampling techniques for different types of deposits (vein, bedded, disseminated, etc.). Calculation of ore reserves: Tonnage factor, cut-off grade, classification of reserves. Methods of reserve estimation: Cross-sectional, longitudinal, triangular, polygonal, and geostatistical methods (basic concepts).	15
Unit 3	**Mining Methods and Geological Considerations** Overview of mining methods: Surface (open-cast, strip mining, placer mining) and underground (room and pillar, longwall mining, cut and fill, block caving). Quarrying operations & rock blasting techniques. Geological factors influencing selection of mining methods. Rock mechanics in mining: Stability of rock slopes and underground openings. Geotechnical investigations for mine-planning.	15
Unit 4	**Mineral Beneficiation, Mineral Economics and Sustainable Mining** Introduction to mineral beneficiation: Comminution, concentration, dewatering. Environmental impact of mining and mitigation measures: Acid mine drainage, land degradation, rehabilitation practices, Waste disposal and tailing management. Mine reclamation, sustainable mineral development. Overview of Indian mining legislation: Mines and Minerals (Development and Regulation) Act, 1957 and amendments. National Mineral Policy. Mining and geopolitics. Concept of mineral economics: resource classification, mineral pricing, impact of market trends on exploration.	15
	Total	**60**

Text Books:

1) Arogyaswamy, R.N.P. (1996). Courses in Mining Geology. Oxford & IBH.
2) Marjoribanks, R. (2010). Geological Methods in Mineral Exploration and Mining. Springer.

Reference Books:

1) Evans, A.M. (1993). Ore Geology and Industrial Minerals. Blackwell.
2) Bell, F.G. (1992). Environmental Geology: Principles and Practice. Blackwell.
3) Indian Bureau of Mines publications and reports.

Course Level: Research	DISSERTATION L-T-P-C: 0-0-0-12 Credits: 12 Scheme of Evaluation: Project	Course Code: GEOL164C423

Course Objective: To develop advanced research skills in geological sciences by conducting independent research, applying analytical tools, and effectively communicating scientific findings.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Prepare a scientific research problem and design a feasible methodology.	**BT 2**
CO 2	Conduct advanced field investigations, data collection, and laboratory analyses.	**BT 3**
CO 3	Apply geospatial, statistical, and computational methods to interpret geological datasets.	**BT 4**
CO 4	Critically evaluate results and draw meaningful geological conclusions.	**BT 5**
CO 5	Write a scientific dissertation, including literature review, methodology, results, and discussion.	**BT 6**

Sl. No.	Research Outline	Timeline
1	**Advanced Research Planning & Proposal Writing** • Selection of research topic and problem formulation. • Review of scientific literature, gap analysis, and research hypothesis formation. • Research proposal writing: Objectives, methodology, data requirements. • Ethical considerations in research (plagiarism, data integrity, authorship).	2 Weeks
2	**Data Collection, Processing & Methodology** • Field investigations: Geological mapping, sampling, geophysical/geochemical surveys. • Data collection techniques: Borehole logging, GIS, remote sensing, petrography, geostatistics. • Experimental methods: XRD, XRF, SEM-EDS, thin section petrography, sediment analysis. • Computational techniques: Python/R for geosciences, RockWorks, ArcGIS/QGIS applications.	4 Weeks
3	**Analysis, Interpretation & Discussion** • Data processing & interpretation: Statistical and spatial analysis, cross-validation. • Conceptual geological models: Structural, hydrogeological, or mineral deposit models. • Comparison with previous studies & existing theories. • Scientific discussions: Uncertainty assessment, limitations of findings.	5 Weeks
4	**Report Writing, Publication & Presentation** • Scientific report structure: Abstract, introduction, methodology, results, discussion, conclusion. • Formatting as per journal/conference standards. • Graphical representation: Maps, cross-sections, geospatial models. • Preparation for oral defence & viva-voce.	4 Weeks
	Total	**15 weeks**

Assessment Criteria:

Component	Marks (%)	Evaluation Criteria
Proposal Presentation	10%	Clarity, feasibility, scientific value
Mid-Term Review & Progress Report	20%	Quality of research progress
Dissertation Report	40%	Depth, originality, scientific rigour
Oral Defence & Viva	20%	Presentation skills, depth of understanding
Research Ethics & Engagement	10%	Effort, interactions, adherence to research norms

Reference Books:

1) Kothari, C. R. (2004). Research Methodology: Methods and Techniques.
2) Davis, J. C. (2002). Statistics and Data Analysis in Geology.
3) Bonham-Carter, G. (1994). Geographic Information Systems for Geoscientists: Modelling with GIS.
4) Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied Geophysics.
5) Montello, D. R., & Sutton, P. C. (2012). An Introduction to Scientific Research Methods in Geography and Environmental Studies.
6) Academic papers & journal articles related to the research topic.

Detailed Syllabus
One-Year M.Sc. Programme
Semester 1

Course Level: 500	ENGINEERING GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C301

Course Objective: To equip students with the principles of engineering geology and geotechnical investigation, focusing on soil and rock mechanics, slope stability, and the geological considerations essential for infrastructure development.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of soil mechanics, rock properties, and geological factors influencing engineering projects.	**BT 1**
CO 2	Understand the fundamental concepts of soil and rock mechanics and their applications in geotechnical engineering.	**BT 2**
CO 3	Apply geological principles in site selection, foundation analysis, and stability assessment of dams, tunnels, and slopes.	**BT 3**
CO 4	Analyse the impact of geological structures and material properties on infrastructure stability and hazard mitigation.	**BT 4**
CO 5	Evaluate engineering problems related to slope stability, tunnel construction, and dam safety using geotechnical investigation methods and GIS-based tools.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Soil and Rock Mechanics** Soil: Engineering properties, unit weight, specific gravity, porosity, void ratio, water content, and degree of saturation. Compressibility, consolidation, compaction, and shear strength of soils. Clay mineralogy and its significance in soil behaviour, Atterberg limits, and soil classification. Engineering properties of rocks: Strength, hardness, elasticity, porosity, and specific gravity. Rock masses: Discontinuities, weathering, and deformation. Engineering classification of rocks and rock masses (RQD, Bieniawski's RMR, Q-system).	12
Unit 2	**Ground Improvement Techniques** Rock mass improvement techniques: Grouting, bolting, anchoring, and shotcreting. Quarrying and rock blasting techniques. Use of rocks as construction materials. Geotechnical properties of aggregates used in construction.	12
Unit 3	**Dams and Reservoirs** Types of engineering geological investigations: Preliminary and Detailed Types and classification of dams. Geological and geophysical investigations for dam foundations and abutments. Foundation and abutment problems: Seepage, bearing strength, and rebound problems. Treatment of weak zones: Grouting, anchoring and rock bolting. Reservoir area investigations, leakage control, and sedimentation issues. Problems associated with earth dams and embankments.	11
Unit 4	**Tunnels, Bridges, and Slope Stability** Geotechnical investigations for tunnel construction: Site selection, geological considerations, groundwater influence, and rock stress conditions. Tunnel excavation methods and support systems. Role of geological discontinuities in tunnel and bridge alignment. Landslide hazard zonation and slope stability analysis. Engineering solutions for slope stability problems using GIS and remote sensing.	10
	Total	**45**

Text Books:

1) Bell, F.G. (2007). Engineering Geology. Elsevier.
2) Krynine, D.P., & Judd, W.R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.

Reference Books:

1) Hobbs, W.R., & Waltham, T. (2002). Foundations of Engineering Geology. Routledge.
2) West, T.R. (2004). Geology Applied to Engineering. Waveland Press.
3) Das, B.M. (2011). Principles of Geotechnical Engineering. Cengage Learning.
4) Goodman, R.E. (1993). Engineering Geology: Rock in Engineering Construction. John Wiley & Sons.

Course Level: 500	ENGINEERING GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C312

Course Objective: To equip students with the principles of engineering geology and geotechnical investigation, focusing on soil and rock mechanics, slope stability, and the geological considerations essential for infrastructure development.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall fundamental concepts of soil mechanics, rock properties, and geological factors influencing engineering projects.	**BT 1**
CO 2	Understand the fundamental concepts of soil and rock mechanics and their applications in geotechnical engineering.	**BT 2**
CO 3	Apply geological principles in site selection, foundation analysis, and stability assessment of dams, tunnels, and slopes.	**BT 3**
CO 4	Analyse the impact of geological structures and material properties on infrastructure stability and hazard mitigation.	**BT 4**
CO 5	Evaluate engineering problems related to slope stability, tunnel construction, and dam safety using geotechnical investigation methods and GIS-based tools.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	Computation of reservoir area, catchment area, reservoir capacity, and reservoir life. Analysis of geological cross-sections for infrastructure projects. Computation of index properties of soils. Determination of RQD, RMR, and Q-values. Shear strength analysis of rocks and soils. Determination of strength of rock mass by GSI (Geological Strength Index) method and uniaxial compressive strength of rocks. GIS-based analysis of slope stability and landslide hazard zonation. Numerical and graphical analysis of geotechnical stability problems (Markland's Test)	30
	Total	**30**

Text Books:

1) Bell, F.G. (2007). Engineering Geology. Elsevier.
2) Krynine, D.P., & Judd, W.R. (2005). Principles of Engineering Geology and Geotechnics. CBS Publishers.

Reference Books:

1) Hobbs, W.R., & Waltham, T. (2002). Foundations of Engineering Geology. Routledge.
2) West, T.R. (2004). Geology Applied to Engineering. Waveland Press.
3) Das, B.M. (2011). Principles of Geotechnical Engineering. Cengage Learning.
4) Goodman, R.E. (1993). Engineering Geology: Rock in Engineering Construction. John Wiley & Sons.

Course Level: 500	ECONOMIC GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C303

Course Objective: To provide a comprehensive understanding of the genesis, classification, and economic significance of ore deposits, along with modern mineral exploration techniques and sustainable resource management.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall the fundamental concepts of ore genesis, classification, and economic significance of mineral deposits using basic scientific principles.	**BT 1**
CO 2	Understand the fundamental processes of ore formation and classification of ore deposits.	**BT 2**
CO 3	Apply geophysical, geochemical, and remote sensing techniques for mineral exploration.	**BT 3**
CO 4	Analyse the structural and geochemical controls governing ore deposition.	**BT 4**
CO 5	Evaluate the distribution, mineralogy, and genesis of major mineral resources in India, including those in North-East India.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals of Ore Genesis and Ore Deposits** Morphology, textural and structural features of ore bodies. Classification of ore deposits: Genetic and descriptive classification. Ore-forming processes: Magmatic, hydrothermal, sedimentary, metamorphic, contact metasomatic, pegmatitic, oxidation and supergene enrichment. SEDEX and VMS deposits, Placer deposits, Laterites. Role of tectonics in ore deposit formation: Metallogeny and crustal evolution. Metallogeny of Archaean greenstone belts and Proterozoic mobile belts.	12
Unit 2	**Structural and Chemical Controls on Ore Formation** Structural controls: Faults, folds, shear zones, unconformities, intrusions. Chemical controls: pH, redox potential, ligand complexing in ore formation. Geochemistry of ore-forming fluids: Stable and radiogenic isotopes in mineral exploration. Application of fluid inclusion studies in ore genesis.	12
Unit 3	**Mineral Resources of India** Distribution, mode of occurrence, mineralogy, and genesis of major mineral deposits in India: • **Critical Minerals**: Nickel, titanium, vanadium, tungsten, chromium, PGE, copper, graphite, manganese, molybdenum, lithium, and REE. • **Strategic Minerals**: Sulphur, lead, petroleum, zinc, mercury, platinum, nickel, graphite, tin, ferro-tungsten. • **Essential Minerals**: Iron ore, manganese, chromite, copper, gold, bauxite, coal, limestone, mica, gypsum, natural gas, thorium, uranium. Introduction to industrial minerals and their economic importance. Gemstones: Occurrence, economic value, and processing techniques.	11
Unit 4	**Applied Economic Geology** Strategic importance of minerals and resource security. Environmental and social impact of mineral extraction and mining sustainability. Role of GIS in mineral resource mapping and exploration. Economic minerals of **North-East India**: Critical, strategic, and essential minerals, with emphasis on petroleum, coal, bauxite, limestone, REE, and uranium.	10
	Total	**45**

Text Books:

1) Evans, A. M. (1993) – Ore Geology and Industrial Minerals, Blackwell Science.
2) Mookherjee, A. (2000) – Ore Genesis: A Holistic Approach, Allied Publishers.

Reference Books:

1) Guilbert, J. M., & Park, C. F. Jr. (1986) – The Geology of Ore Deposits, Freeman.
2) Dutta, S. (2014) – Economic Geology: Economic Mineral Deposits, CBS Publishers.
3) Craig, J. R., Vaughan, D. J., & Skinner, B. J. (2011) – Resources of the Earth: Origin, Use, and Environmental Impact, Pearson.
4) Robb, L. J. (2005) – Introduction to Ore-Forming Processes, Wiley-Blackwell.
5) Deb, M. & Goodfellow, W. D. (2004) – Sediment-Hosted Lead-Zinc Sulphide Deposits: Attributes and Models of Some Major Deposits in India and Canada, Elsevier.
6) Geological Survey of India (GSI) Publications – Reports on Mineral Deposits in India.

Course Level: 500	ECONOMIC GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C314

Course Objective: To provide a comprehensive understanding of the genesis, classification, and economic significance of ore deposits, along with modern mineral exploration techniques and sustainable resource management.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall the fundamental concepts of ore genesis, classification, and economic significance of mineral deposits using basic scientific principles.	**BT 1**
CO 2	Understand the fundamental processes of ore formation and classification of ore deposits.	**BT 2**
CO 3	Apply geophysical, geochemical, and remote sensing techniques for mineral exploration.	**BT 3**
CO 4	Analyse the structural and geochemical controls governing ore deposition.	**BT 4**
CO 5	Evaluate the distribution, mineralogy, and genesis of major mineral resources in India, including those in North-East India.	**BT 5**

Modules	Topics and Course Content	Hours

Unit 1	**Megascopic Identification of Ore and Industrial Minerals**
	• Physical properties (lustre, streak, hardness, density, cleavage, colour, etc.)
	• Identification of:
	  o **Metallic ores**: Hematite, magnetite, chalcopyrite, galena, sphalerite, pyrolusite, chromite, malachite, bauxite.
	  o **Industrial minerals**: Barite, fluorite, gypsum, mica, talc, graphite, kyanite, quartz, feldspar.
	Ore Microscopy (Under Reflected Light)
	• Introduction to reflected light microscopy.
	• Textural identification: granular, colloform, intergrowths, cataclastic, replacement textures.
	• Microscopic study and description of:
	  o **Sulphide ores**: Chalcopyrite, pyrite, galena, sphalerite, bornite.
	  o **Oxide ores**: Hematite, magnetite, cassiterite, chromite, ilmenite.
	• Interpretation of ore textures in relation to ore genesis.
		10

Unit 2	**Preparation and Description of Paragenetic Sequences**
	• Drawing paragenetic sequence diagrams from given case studies.
	• Interpretation of ore-forming environments based on textural and mineralogical relationships.
	Map and Cross-section Based Practical
	• Interpretation of geological maps showing:
	  o Structural controls on ore deposits (faults, folds, unconformities).
	  o Ore body geometry and zoning patterns.
	• Location and marking of major **mineral belts and basins** on:
	  o **Indian Geological Map**: Singhbhum, Aravalli, Dharwar, Bastar, North-East India.
		7

Unit 3	**Practical on Mineral Exploration Techniques** • Overview of sampling methods (stream sediment, soil, trench, borehole). • Introduction to **fluid inclusion diagrams** and their geological interpretation. • Basics of **geochemical data interpretation** for exploration. • Study of **GIS-based mineral resource maps** (GSI/Bhuvan demo datasets or static images).	8
Unit 4	**Gemstone Identification and Properties** • Physical identification of important gemstones: garnet, beryl, corundum, quartz varieties (amethyst, citrine), topaz. • Study of gemstone enhancement and valuation basics.	5
	Total	**30**

Text Books:

1) Evans, A. M. (1993) – Ore Geology and Industrial Minerals, Blackwell Science.
2) Mookherjee, A. (2000) – Ore Genesis: A Holistic Approach, Allied Publishers.

Reference Books:

1) Guilbert, J. M., & Park, C. F. Jr. (1986) – The Geology of Ore Deposits, Freeman.
2) Dutta, S. (2014) – Economic Geology: Economic Mineral Deposits, CBS Publishers.
3) Craig, J. R., Vaughan, D. J., & Skinner, B. J. (2011) – Resources of the Earth: Origin, Use, and Environmental Impact, Pearson.
4) Robb, L. J. (2005) – Introduction to Ore-Forming Processes, Wiley-Blackwell.
5) Deb, M. & Goodfellow, W. D. (2004) – Sediment-Hosted Lead-Zinc Sulphide Deposits: Attributes and Models of Some Major Deposits in India and Canada, Elsevier.
6) Geological Survey of India (GSI) Publications – Reports on Mineral Deposits in India.

Course Level: 500	FUEL GEOLOGY L-T-P-C: 3-0-0-3 Credits: 3 Scheme of Evaluation: Theory	Course Code: GEOL164C305

Course Objective: To provide students with a comprehensive understanding of the origin, classification, exploration, and economic significance of coal, petroleum, and natural gas, with a focus on their geological characteristics, distribution, and environmental considerations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define the fundamental concepts related to the origin, classification, and properties of coal and petroleum.	**BT 1**
CO 2	Understand the processes of coalification, petroleum formation, migration, accumulation, and trapping mechanisms.	**BT 2**
CO 3	Apply coal and petroleum classification systems, analytical techniques, and petrographic methods to assess fuel resources.	**BT 3**
CO 4	Analyse geological, geochemical, and structural factors influencing the occurrence and distribution of coal and petroleum reserves.	**BT 4**
CO 5	Evaluate the economic significance, industrial applications, and environmental impact of fossil fuel exploration and extraction.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Origin and Formation of Coal** Coal forming processes. Climatic, paleogeographic, and tectonic conditions for peat swamp development. Sedimentation of coal-bearing sequences and geological features of coal seams. Diagenesis of peat, coalification processes, and changes in coal properties. Causes of coalification and classification of coal ranks.	12
Unit 2	**Coal Analysis, Petrography, and Indian Coal Deposits** Coal sampling and analysis: proximate and ultimate analysis. Physical and chemical properties of coal, trace elements, and environmental concerns. Coal petrography: macroscopic and microscopic properties, maceral classification, microlithotypes. Classification and industrial applications of coal. Geological and geographical distribution of Indian coal deposits, with a focus on NE India.	12
Unit 3	**Origin and Characteristics of Petroleum** Basic components of petroleum and its physical properties. Theories of petroleum origin: organic and inorganic theories. Source rock definition, types, and transformation processes (diagenesis, catagenesis, metagenesis). Characteristics of source rocks, reservoir rocks, and cap rocks. Types of reservoir rocks: clastic, carbonate, fractured, marine, and non-marine reservoirs.	11
Unit 4	**Hydrocarbon Migration, Accumulation, and Indian Oil and Gas Fields** Hydrocarbon migration: primary and secondary migration mechanisms. Classification of hydrocarbon traps: structural, stratigraphic, and combination types. Classification of petroliferous basins of India. Major oil and gas fields of India: Assam, Arunachal Pradesh, Nagaland, Tripura, Mizoram, Cambay Basin, Bombay Offshore, Krishna-Godavari Basin. Environmental impact of hydrocarbon exploration and extraction.	10
	Total	**45**

Text Books:

1) Thomas, L. (2020). Coal Geology (3rd Edition). Wiley-Blackwell.
2) Tissot, B. P., & Welte, D. H. (1984). Petroleum Formation and Occurrence. Springer.

Reference Books:

1) Singh, R. M. (1997). Coal and Organic Petrology. Hindustan Publishing Corporation.
2) Stach, E., Taylor, G. H., Mackowsky, M. T., Teichmüller, M., & Chandra, D. (1982). Stach's Textbook of Coal Petrology. Gebrüder Borntraeger.
3) Diessel, C. F. K. (1992). Coal-bearing Depositional Systems. Springer.
4) North, F. K. (1985). Petroleum Geology. Allen & Unwin.
5) Doust, H., & Chapman, M. (2018). Hydrocarbon Exploration & Production. Elsevier.
6) Allen, P. A., & Allen, J. R. (2013). Basin Analysis: Principles and Application to Petroleum Play Assessment. Wiley-Blackwell.

Course Level: 500	FUEL GEOLOGY PRACTICAL L-T-P-C: 0-0-2-1 Credits: 1 Scheme of Evaluation: Practical	Course Code: GEOL164C316

Course Objective: To provide students with a comprehensive understanding of the origin, classification, exploration, and economic significance of coal, petroleum, and natural gas, with a focus on their geological characteristics, distribution, and environmental considerations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define the fundamental concepts related to the origin, classification, and properties of coal and petroleum.	**BT 1**
CO 2	Understand the processes of coalification, petroleum formation, migration, accumulation, and trapping mechanisms.	**BT 2**
CO 3	Apply coal and petroleum classification systems, analytical techniques, and petrographic methods to assess fuel resources.	**BT 3**
CO 4	Analyse geological, geochemical, and structural factors influencing the occurrence and distribution of coal and petroleum reserves.	**BT 4**
CO 5	Evaluate the economic significance, industrial applications, and environmental impact of fossil fuel exploration and extraction.	**BT 5**

Modules	Topics and Course Content	Hours

Unit 1	**Megascopic Study of Coal Samples**
	• Identification of coal types based on:
	  o Colour, lustre, hardness, streak, and breakage.
	  o Recognition of **coal ranks**: lignite, sub-bituminous, bituminous, and anthracite.
	• Recording physical and structural features of coal (cleat, banding, parting, mineral matter).
	Proximate Analysis of Coal
	• Demonstration or interpretation of laboratory data to determine:
	  o **Moisture content**
	  o **Volatile matter**
	  o **Ash content**
	  o **Fixed carbon**
	• Interpretation of results to assess coal quality for industrial applications.
	Microscopic Petrography of Coal (Vitrinite Reflectance + Maceral Study)
	• Identification of macerals under reflected light microscope:
	  o **Vitrinite group** (telinite, collinite)
	  o **Liptinite group** (sporinite, cutinite)
	  o **Inertinite group** (fusinite, semifusinite)
	• Classification of **microlithotypes**: vitrite, clarite, durite, fusite, etc.
	• Estimation of vitrinite reflectance and its use in determining **coal rank**.
	Coal Deposit Mapping – Indian Context
	• Study and interpretation of **coal distribution maps** of India.
	• Marking major **coalfields**: Jharia, Raniganj, Bokaro, Talcher, Singrauli, Makum, Namchik-Namphuk (Arunachal), Tikak (Assam), etc.
	• Preparation of stratigraphic columns showing coal-bearing horizons in India.
		15

Unit 2	**Study of Indian Petroleum Fields (Map Work)**
	• Plotting major **oil and gas fields of India**:
	  o Assam-Arakan Basin, Bombay High, Krishna-Godavari Basin, Cambay Basin, Cauvery Basin, Rajasthan Basin.
	• Classification of **petroliferous basins** based on tectonic setting (per DGH/ONGC classification).
	Interpretation of Hydrocarbon Traps (Block Diagrams / Sections)
	• Study and sketching of models:
	  o **Structural traps**: anticline, fault traps, domes.
	  o **Stratigraphic traps**: pinch-out, unconformity traps.
	  o **Combination traps**: faulted anticlines.
	• Case examples from Indian basins.
	Study of Wireline Logs (Demo/Simulated Logs)
	• Introduction to **SP (Spontaneous Potential)** and **Resistivity Logs**.
	• Interpretation of hydrocarbon zones using log responses.
	• Simple exercises to identify reservoir and water zones.
	Interpretation of structure contour maps and isopach maps.
	Reserve estimation and calculation for coal and petroleum deposits.
		15

	Total	**30**

Text Books:

1) Thomas, L. (2020). Coal Geology (3rd Edition). Wiley-Blackwell.
2) Tissot, B. P., & Welte, D. H. (1984). Petroleum Formation and Occurrence. Springer.

Reference Books:

1) Singh, R. M. (1997). Coal and Organic Petrology. Hindustan Publishing Corporation.
2) Stach, E., Taylor, G. H., Mackowsky, M. T., Teichmüller, M., & Chandra, D. (1982). Stach's Textbook of Coal Petrology. Gebrüder Borntraeger.
3) Diessel, C. F. K. (1992). Coal-bearing Depositional Systems. Springer.
4) North, F. K. (1985). Petroleum Geology. Allen & Unwin.
5) Doust, H., & Chapman, M. (2018). Hydrocarbon Exploration & Production. Elsevier.
6) Allen, P. A., & Allen, J. R. (2013). Basin Analysis: Principles and Application to Petroleum Play Assessment. Wiley-Blackwell.

Course Level: Research	Pre-Dissertation Research L-T-P-C: 0-0-0-8 Credits: 8 Scheme of Evaluation: Project	Course Code: GEOL164C327

Course Objective: To enable students to conduct minor-level research by identifying a geoscientific problem, applying appropriate methodologies, and interpreting results systematically, fostering independent thinking and research skills.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Understand the fundamentals of research methodology, scientific writing, and data interpretation in geological studies.	**BT 2**
CO 2	Formulate a research problem, collect and analyse geological data using appropriate field and laboratory techniques.	**BT 3**
CO 3	Interpret geological datasets and present scientific arguments logically and coherently.	**BT 4**
CO 4	Critically assess existing literature and integrate findings to support research conclusions.	**BT 5**
CO 5	Develop a well-structured research report/dissertation and present research findings effectively.	**BT 6**

Sl. No.	Research Outline	Timeline
1	**Introduction to Research & Project Planning** • Fundamentals of research methodology in geosciences • Identifying a research problem and defining objectives • Literature review: sources, citation, and referencing (use of software like Mendeley/Zotero) • Research ethics, plagiarism, and scientific integrity	2 Weeks
2	**Methodology & Data Collection** • Selection of appropriate methods for field/laboratory studies • Techniques in geological mapping, remote sensing, GIS, and geophysical/geochemical analyses • Sampling techniques and data acquisition methods • Use of software for data processing (e.g., QGIS, MATLAB, RockWorks, Surfer, ORIGIN)	5 Weeks
3	**Data Analysis & Interpretation** • Statistical and graphical representation of data • Quantitative and qualitative interpretation of results • Comparing findings with existing literature • Error analysis and uncertainty assessment	4 Weeks
4	**Report Writing & Presentation** • Structure of a research dissertation: Abstract, Introduction, Methodology, Results, Discussion, Conclusion, References • Formatting and writing scientific reports (following university guidelines) • Preparing research posters and PowerPoint presentations • Oral defence and viva-voce examination	4 Weeks
	Total	**15 weeks**

Assessment Criteria:

Component	Marks (%)	Evaluation Criteria
Proposal Submission	10%	Research question, objectives, feasibility
Mid-Term Review	20%	Progress, data collection, preliminary analysis
Final Report	40%	Report quality, analysis, interpretation, presentation
Oral Presentation & Viva	20%	Clarity, content, response to questions
Work Ethics & Engagement	10%	Attendance, effort, interaction with supervisor

Reference Books:

1) Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Age International.
2) Press, F., & Siever, R. (2001). Understanding Earth. W. H. Freeman.
3) Tucker, M. E. (2011). Sedimentary Rocks in the Field: A Practical Guide. Wiley-Blackwell.
4) Compton, R. R. (1985). Geology in the Field. Wiley.
5) Petrie, E. S., & Boggs, S. (2007). Geological Field Techniques. Wiley.
6) Academic papers & journal articles related to the research topic.

Detailed Syllabus
One-Year M.Sc. Programme
Semester 2

Course Level: 500	EXPLORATION GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C401

Course Objective: To provide a comprehensive understanding of geological, geochemical, geophysical, and remote sensing methods used in mineral and hydrocarbon exploration, while integrating modern techniques, sustainability, and planning stages relevant to contemporary exploration programmes.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Identify and recall fundamental concepts, terminologies, and techniques used in geological, geophysical, and geochemical exploration.	**BT 1**
CO 2	Explain the principles behind different exploration methods and interpret the role of rock properties and surface features in resource identification.	**BT 2**
CO 3	Demonstrate the application of various exploration tools such as geochemical pathfinders, geophysical instruments, and remote sensing data in field or simulated exploration tasks.	**BT 3**
CO 4	Critically analyse subsurface data (e.g., seismic, resistivity, logging) to delineate potential mineral or hydrocarbon-bearing zones.	**BT 4**
CO 5	Assess the effectiveness and limitations of exploration techniques in different geological terrains and evaluate exploration data for feasibility reporting.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Fundamentals and Planning of Exploration** Scope and importance of exploration geology in mineral and hydrocarbon industries Physical properties of rocks: density, magnetic susceptibility, resistivity, elastic wave velocities Factors influencing rock properties and their relevance to exploration Exploration planning stages: reconnaissance, detailed investigation, feasibility studies Environmental and sustainability concerns during exploration activities	15
Unit 2	**Geological, Geochemical, and Geobotanical Methods** Geological mapping and litho-structural interpretation in exploration Geochemical exploration: surface and subsurface sampling methods, pathfinder elements, data interpretation Geobotanical prospecting: principles, indicator plant species, and practical applications Introduction to geostatistics: sampling strategies, resource/reserve estimation basics	15
Unit 3	**Geophysical Exploration Techniques** Seismic methods: principles of reflection and refraction, seismic tomography Gravity and magnetic methods: instrumentation, survey techniques, data interpretation Electrical methods: resistivity surveys, induced polarisation (IP), self-potential (SP) Remote Sensing & GIS in mineral exploration: multispectral/hyperspectral imaging, spectral analysis for mineral targeting, integration with GIS	15
Unit 4	**Drilling, Logging, and Subsurface Investigations** Drilling techniques: core drilling, rotary drilling, directional drilling – applications and limitations Well logging techniques: SP, GR, resistivity, neutron, density, and sonic logs – interpretation and applications Role of well-site geologists in exploration drilling Surface and subsurface methods of mineral prospecting	15
	Total	**60**

Text Books:

1) Moon, C.J., Whateley, M.K.G., & Evans, A.M. (2006) - Introduction to Mineral Exploration (Wiley).
2) Robb, L. (2005) - Introduction to Ore-Forming Processes (Wiley-Blackwell).

Reference Books:

1) Dobrin, M.B. & Savit, C.H. (1988) - Introduction to Geophysical Prospecting (McGraw-Hill).
2) Telford, W.M., Geldart, L.P., & Sheriff, R.E. (1990) - Applied Geophysics (Cambridge University Press).
3) Kearey, P., Brooks, M., & Hill, I. (2002) - An Introduction to Geophysical Exploration (Wiley).
4) Craig, J.R., Vaughan, D.J., & Skinner, B.J. (2011) - Resources of the Earth: Origin, Use, and Environmental Impact (Pearson).
5) Gates, A.E. (2003) - Mining and Its Impact on the Environment (Taylor & Francis).

Course Level: 500	MINING GEOLOGY L-T-P-C: 3-1-0-4 Credits: 4 Scheme of Evaluation: Theory	Course Code: GEOL164C402

Course Objective: This course aims to equip students with comprehensive knowledge and practical understanding of the principles, methods, and applications of mining geology, including ore exploration, sampling, reserve estimation, mining techniques, and environmental and legal considerations associated with mining operations.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Recall and define fundamental concepts and terminologies related to mining geology, including mining methods, ore sampling, and reserve estimation.	**BT 1**
CO 2	Explain the processes of ore exploration, evaluation, and different mining techniques along with their geological implications.	**BT 2**
CO 3	Apply geological knowledge to identify suitable mining methods and perform basic calculations related to ore reserve estimation.	**BT 3**
CO 4	Analyse geological, structural, and economic factors that influence the selection of mining sites and techniques.	**BT 4**
CO 5	Evaluate the feasibility, efficiency, and environmental implications of various mining operations and plans.	**BT 5**

Modules	Topics and Course Content	Hours
Unit 1	**Basic Concepts in Mining Geology** Scope of mining geology: Role of a geologist in mining industry. Life cycle of a mining project: Exploration, feasibility, development, production, and closure. Classification of mineral deposits based on mining methods. Geological, economic, and technological factors influencing mine-development. Drilling techniques: Core and non-core drilling, planning of drilling programmes.	15
Unit 2	**Sampling and Ore Reserve Estimation** Principles and methods of sampling: Channel, chip, grab, bulk sampling. Sampling techniques for different types of deposits (vein, bedded, disseminated, etc.). Calculation of ore reserves: Tonnage factor, cut-off grade, classification of reserves. Methods of reserve estimation: Cross-sectional, longitudinal, triangular, polygonal, and geostatistical methods (basic concepts).	15
Unit 3	**Mining Methods and Geological Considerations** Overview of mining methods: Surface (open-cast, strip mining, placer mining) and underground (room and pillar, longwall mining, cut and fill, block caving). Quarrying operations & rock blasting techniques. Geological factors influencing selection of mining methods. Rock mechanics in mining: Stability of rock slopes and underground openings. Geotechnical investigations for mine-planning.	15
Unit 4	**Mineral Beneficiation, Mineral Economics and Sustainable Mining** Introduction to mineral beneficiation: Comminution, concentration, dewatering. Environmental impact of mining and mitigation measures: Acid mine drainage, land degradation, rehabilitation practices, Waste disposal and tailing management. Mine reclamation, sustainable mineral development. Overview of Indian mining legislation: Mines and Minerals (Development and Regulation) Act, 1957 and amendments. National Mineral Policy. Concept of mineral economics: resource classification, mineral pricing, impact of market trends on exploration.	15
	Total	**60**

Text Books:

1) Arogyaswamy, R.N.P. (1996). Courses in Mining Geology. Oxford & IBH.
2) Marjoribanks, R. (2010). Geological Methods in Mineral Exploration and Mining. Springer.

Reference Books:

1) Evans, A.M. (1993). Ore Geology and Industrial Minerals. Blackwell.
2) Bell, F.G. (1992). Environmental Geology: Principles and Practice. Blackwell.
3) Indian Bureau of Mines publications and reports.

Course Level: Research	DISSERTATION L-T-P-C: 0-0-0-12 Credits: 12 Scheme of Evaluation: Project	Course Code: GEOL164C423

Course Objective: To develop advanced research skills in geological sciences by conducting independent research, applying analytical tools, and effectively communicating scientific findings.

Course Outcomes	Description	Bloom's Taxonomy
CO 1	Prepare a scientific research problem and design a feasible methodology.	**BT 2**
CO 2	Conduct advanced field investigations, data collection, and laboratory analyses.	**BT 3**
CO 3	Apply geospatial, statistical, and computational methods to interpret geological datasets.	**BT 4**
CO 4	Critically evaluate results and draw meaningful geological conclusions.	**BT 5**
CO 5	Write a scientific dissertation, including literature review, methodology, results, and discussion.	**BT 6**

Sl. No.	Research Outline	Timeline
1	**Advanced Research Planning & Proposal Writing** • Selection of research topic and problem formulation. • Review of scientific literature, gap analysis, and research hypothesis formation. • Research proposal writing: Objectives, methodology, data requirements. • Ethical considerations in research (plagiarism, data integrity, authorship).	2 Weeks
2	**Data Collection, Processing & Methodology** • Field investigations: Geological mapping, sampling, geophysical/geochemical surveys. • Data collection techniques: Borehole logging, GIS, remote sensing, petrography, geostatistics. • Experimental methods: XRD, XRF, SEM-EDS, thin section petrography, sediment analysis. • Computational techniques: Python/R for geosciences, RockWorks, ArcGIS/QGIS applications.	4 Weeks
3	**Analysis, Interpretation & Discussion** • Data processing & interpretation: Statistical and spatial analysis, cross-validation. • Conceptual geological models: Structural, hydrogeological, or mineral deposit models. • Comparison with previous studies & existing theories. • Scientific discussions: Uncertainty assessment, limitations of findings.	5 Weeks
4	**Report Writing, Publication & Presentation** • Scientific report structure: Abstract, introduction, methodology, results, discussion, conclusion. • Formatting as per journal/conference standards. • Graphical representation: Maps, cross-sections, geospatial models. • Preparation for oral defence & viva-voce.	4 Weeks
	Total	**15 weeks**

Assessment Criteria:

Component	Marks (%)	Evaluation Criteria
Proposal Presentation	10%	Clarity, feasibility, scientific value
Mid-Term Review & Progress Report	20%	Quality of research progress
Dissertation Report	40%	Depth, originality, scientific rigour
Oral Defence & Viva	20%	Presentation skills, depth of understanding
Research Ethics & Engagement	10%	Effort, interactions, adherence to research norms

Reference Books:

1) Kothari, C. R. (2004). Research Methodology: Methods and Techniques.
2) Davis, J. C. (2002). Statistics and Data Analysis in Geology.
3) Bonham-Carter, G. (1994). Geographic Information Systems for Geoscientists: Modelling with GIS.
4) Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied Geophysics.
5) Montello, D. R., & Sutton, P. C. (2012). An Introduction to Scientific Research Methods in Geography and Environmental Studies.
6) Academic papers & journal articles related to the research topic.