गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP/2025-26/214 Date: 02.07.2025

CIRCULAR

The Academic Council & Executive Council of the University has approved Ordinance OA-35A relating to PG Programmes offered at the University campus and its affiliated Colleges based on UGC 'Curriculum and Credit Framework for Postgraduate Programmes'. Accordingly, the University has proposed introduction of Ordinance OA-35A from the Academic year 2025-2026 onwards.

The Programme structure and syllabus of Semester I and II of the **Master of Science in Applied Geology** Programme approved by the Academic Council in its meeting held on 13th & 14th June 2025 is attached.

The Dean & Vice-Dean (Academic) of the School of Earth, Ocean and Atmospheric Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned**.**

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.07.02 17:06:41 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, School of Earth, Ocean and Atmospheric Sciences, Goa University.
2. The Vice-Dean (Academic), School of Earth, Ocean and Atmospheric Sciences, Goa University.

Copy to:
1. Chairperson, BoS in Earth Science, Goa University.
2. Programme Director, M.Sc. Applied Geology, Goa University.
3. Controller of Examinations, Goa University.
4. Assistant Registrar Examinations (PG), Goa University.
5. Director, Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

Master of Science in Applied Geology

(Effective from the academic year 2025-2026)

ABOUT THE PROGRAMME

Geology is one of the fundamental scientific disciplines of study which deals with understanding the earth and its processes - both operating on the earth as well as in its interior. Its study helps to manage resources and prepare for natural disasters. It provides insights into the earth's history, improves our knowledge of environmental challenges and is essential for resource exploration and extraction. This discipline is important in order to know how geological processes affect our lives and will continue to affect. Geologists play a very important role in various fields like natural resource exploration, environmental protection and hazard assessment, locating valuable mineral deposits, and predicting earthquakes and others. Geologists use their expertise to safeguard our planet and its inhabitants.

The program offers courses and research opportunities for advanced study in geology, mineralogy, petrology, remote sensing, GIS, petroleum geology, groundwater geology, structural geology, environmental geology, mining geology, climate geology, engineering geology and microplastic pollution. The program has an established museum featuring an extensive collection of minerals, rocks, ores and fossils.

OBJECTIVES OF THE PROGRAMME

To focus on understanding fundamental principles and concepts and to gain theoretical and practical knowledge of geological science which will enable recognition, evaluation, carry out interpretation, and understanding and solving of issues in the geological domain.

Approved by: Academic Council on 13th & 14th June 2025

PROGRAMME SPECIFIC OUTCOMES (PSO)	
PSO 1.	Describe the science of the origin, composition, age and evolution of the Earth and/or other objects in the universe.
PSO 2.	Interpret the geological processes that lead to changes in the interior and exterior of the Earth
PSO 3.	Analyse geological problems
PSO 4.	Undertake field work and prepare geological maps
PSO 5.	Explain geological processes and implications of climate change
PSO 6.	To carry out research in Earth Science
PSO 7.	Identify causes of pollution and Natural Hazards and provide mitigation

PROGRAMME STRUCTURE

Master of Science in Applied Geology Effective from the Academic Year 2025-2026

Bridge Course			
Sr. No.	**Course Code**	**Title of the Course**	**Credits**
1	GEO-1000	Bridge course in Applied Geology	2

SEMESTER I					
Discipline Specific Core (DSC) Courses (16 credits)					
Sr. No.	**Course Code**	**Title of the Course**	**L-P (Hrs/week)**	**Credits (s)**	**Level**
1	GEO-5000	Mineralogy and Geochemistry	3-0	3	400
2	GEO-5001	Practical of Mineralogy and Geochemistry	0-2	1	400
3	GEO-5002	Structural Geology and Geotectonics	3-0	3	400
4	GEO-5003	Practical of Structural Geology and Geotectonics	0-2	1	400
5	GEO-5004	Igneous Petrology	3-0	3	400
6	GEO-5005	Practical of Igneous Petrology	0-2	1	400
7	GEO-5006	Economic Geology	3-0	3	400
8	GEO-5007	Practical of Economic Geology	0-2	1	400
Total Credits for DSC Courses in Semester I				**16**	
Discipline Specific Elective (DSE) (4 Credits)					
Sr. No.	**Course Code**	**Title of the Course**	**L-P (Hrs/week)**	**Credits (s)**	**Level**
1	GEO-5201	Marine Geology	3-0	3	400
2	GEO-5202	Practical of Marine Geology	0-2	1	400
3	GEO-5203	Environmental Geology	3-0	3	400
4	GEO-5204	Practical of Environmental Geology	0-2	1	400
Total Credits for DSE Courses in Semester I				**4**	
Total Credits in Semester I				**20**	

SEMESTER II					
Discipline Specific Core (DSC) Courses (16 credits)					
Sr. No.	**Course Code**	**Title of the Course**	**L-P (Hrs/week)**	**Credits (s)**	**Level**
1	GEO-5008	Sedimentology	3-0	3	500
2	GEO-5009	Practical of Sedimentology	0-2	1	500
3	GEO-5010	Metamorphic Petrology	3-0	3	500
4	GEO-5011	Practical of Metamorphic Petrology	0-2	1	500
5	GEO-5012	Stratigraphy and Indian Geology	3-0	3	500
6	GEO-5013	Practical of Stratigraphy and Indian Geology	0-2	1	500
7	GEO-5014	Geological Field Mapping (Skilled Based Course)	1-0	1	500
8	GEO-5015	Practical Geological Field Mapping (Skilled Based Course)	0-6	3	500
Total Credits for DSC Courses in Semester II				**16**	
Discipline Specific Elective (DSE) (4 Credits)					
Sr. No.	**Course Code**	**Title of the Course**	**L-P (Hrs/week)**	**Credits (s)**	**Level**
1	GEO-5205	Exploration Geophysics	3-0	3	400
2	GEO-5206	Practical of Exploration Geophysics	0-2	1	400
3	GEO-5207	Petroleum Geology (Skill Based Course)	3-0	3	400
4	GEO-5208	Practical of Petroleum Geology (Skill Based Course)	0-2	1	400
Total Credits for DSE Courses in Semester II				**4**	
Total Credits in Semester II				**20**	

Blooms Taxonomy Cognitive Levels	
Cognitive Level	**Notations**
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create

BRIDGE COURSE

Title of the Course	Bridge Course in Applied Geology
Course Code	GEO-1000
Number of Credits	02
Theory/Practical	Theory
Level	100
Effective from AY	2025-26
New Course	Yes
Bridge Course/ Value added Course	Yes
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. The student will learn to describe minerals and rocks. 2. Describe the various structural elements in rocks. 3. Understand the various ore forming processes. 4. To study the water cycle and its distribution.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Identify and classify minerals and rocks and the process leading to their formation.	PSO1, PSO2
	CO 2. Explore the various structural aspects that rocks are subjected to.	PSO1, PSO2

	CO 3. Describe the various ore forming processes.		PSO1, PSO2	
	CO 4. Discuss the movement of groundwater and its societal relevance.		PSO1, PSO2	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Importance and scope of Igneous Petrology in Earth Sciences. Source regions of magma:mantle and crust. Processes of magma generation (partial melting). Types of magma (basaltic, andesitic, rhyolitic). Texture and composition of common igneous rocks. Intrusive and extrusive igneous rocks. Classification of igneous rocks. Basics of Sedimentary Rocks: Classification, textures, and structures of clastic and non-clastic rocks.Sedimentary Processes: Weathering, erosion, transport, deposition (Hjulstrom diagram), and diagenesis.Sedimentary Environments: Overview of terrestrial and marine depositional settings and controlling factors. Classification of Minerals: Silicates and Non-silicates. Opaque and transparent minerals. Structure of silicate minerals - Nesosilicates, sorosilicates, inosilicates, cyclosilicates, phyllosilicates and tectosilicates. Description of following silicate mineral groups with respect to chemical composition, structure, physical properties and paragenesis: olivine, pyroxene, amphibole and mica. Definition of metamorphism, upper and lower limits of metamorphism, Migmatites: components, classification into metatexite and ditexite, structures: dilation, stromatic, net, agmatite, Schlieren, schollen, nebulitic, raft-like, vein. Factors responsible for metamorphism: Heat (radioactive, magmatic, tectonic heat), geothermal gradient (in different crustal regions); pressure (P) (directed and load pressure); composition of the parent rock- Protolith (X); fluids (H2O and CO2) (Xf); Role of time in metamorphism.	**15**	CO1	K1,K2

Module 2:	Contours, contour reading and contour patterns; Scale and compass bearing, Stratification, Strike, Dip (true and apparent dip), Strike and Dip symbols. Folds: Causes and geometric classification of folds; importance of folds Joints: Geometric classification, importance; Faults: general characteristics, geometric classification and importance, Horst, Graben and Thrust faults. Ore deposits and ore minerals; Magmatic processes of ore mineralization - Orthomagmatic, pegmatitic, pyro metasomatic and hydrothermal deposits. Wall rock alteration. Oxidation and supergene sulphide enrichment.; Plate tectonics in relation to ore genesis. Secondary processes of ore formation- placer deposits, residual deposits, deposits associated with metamorphic rocks.; Formation of coal, oil and natural gas. Stratigraphy: scope and importance; Principles of Stratigraphy: Laws of uniformitarianism, original horizontality, order of superposition, faunal succession, cross-cutting relationship, inclusions;Standard Stratigraphic timescale; Indian stratigraphic timescale; Geological Time Units: - Eon, Era, Period, Epoch, Age, Phase. Chronostratigraphic Units: - Erathem, System, Series, Stage and Zone. Lithostratigraphic Units: - Group, Formation, Member, Bed and laminae. Introduction. Scope of hydrogeology and its societal relevance, Hydrological cycle and its components: precipitation, evaporation, transpiration, evapotranspiration, surface storage, overland flow, infiltration, soil moisture, interflow, percolation, groundwater recharge and storage, baseflow and surface runoff, Instruments for measurement of precipitation, evapotranspiration, infiltration and streamflow. Concepts of watershed, drainage network, and their relation to surface runoff and infiltration.	**15**	CO2	K1, K2
Pedagogy:	Lectures/ tutorials/assignments			
Text	1. Best, M. G. (2013). Igneous and metamorphic petrology. John Wiley & Sons.			

	2. Winter, J. D. (2013). Principles of igneous and metamorphic petrology: Pearson New International Edition. Pearson Higher Ed. 3. Tucker, M. E. (2013). Sedimentary petrology: An Introduction to the Origin of Sedimentary Rocks. John Wiley & Sons. 4. Pettijohn, F. J. (1969). Sedimentary rocks. CBS Publication and distribution. 5. Boggs, S., Jr, & Boggs, S. (2009). Petrology of sedimentary rocks. Cambridge University Press. 6. Greensmith, J. (2012). Petrology of the sedimentary rocks. Springer Science & Business Media. 7. Folk, R. L. (1980). Petrology of sedimentary rocks. Hemphill Publishing Company 6. Nichols, G. (1999). Sedimentology and Stratigraphy. John Wiley & Sons. 8. Berry and Mason: Mineralogy. CBS Publ. and Distr. 9. Deer, W. A., Howie, R. A., & Zussman, J. (1978). Rock-forming minerals: Feldspars, Volume 4A. Geological Society of London. 10. Klein, C., & Hurlbut, C. S. Jr. (2021). Dana manual of mineralogy. Wiley. 11. Duff, P. M. D. (1993). Holmes' Principles of Physical Geology. Springer. 12. Jain, S. (2014). Fundamentals of Physical Geology. Springer Geology 13. Taylor, R. (2010). Ore textures: recognition and interpretation. Springer Science & Business Media. 14. Arndt, N., Kesler, S., & Ganino, C. (2015). Metals and society: An introduction to economic geology. Springer. 15. Brookfield, M. E. (2008). Principles of Stratigraphy. John Wiley & Sons. 16. Hiscock, K. M. (2005). Hydrogeology: Principles and practice. Blackwell Publishing. 17. Todd, D.K. (2006). Groundwater Hydrology, 2nd Ed., John Wiley & Sons, N.Y.

SEMESTER I

Discipline Specific Core Courses

Title of the Course	Mineralogy and Geochemistry
Course Code	GEO-5000
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Explain the principles of crystal chemistry, including atomic structures, bonding, and mineral stability. 2. Explore the structural, chemical, and paragenetic characteristics of major mineral groups 3. Describe the behaviour and distribution of elements through geochemical processes across different tectonic settings. 4. Discuss analytical techniques for mineralogical and geochemical investigations.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**

	CO 1. Apply crystallographic principles to explain crystal structures.		PSO1, PSO2, PSO6	
	CO 2. Analyze phase equilibrium relationships and mechanisms of polymorphic transformations.		PSO1, PSO2, PSO3, PSO6	
	CO 3. Identify and classify rock-forming minerals using optical and analytical methods.		PSO1, PSO2, PSO4, PSO6	
	CO 4. Analyze the geochemical signatures of igneous, sedimentary, and metamorphic rocks in relation to trace element behaviour and isotopic systems.		PSO, PSO2, PSO3, PSO4, PSO6	
	CO 5. Apply instrumental techniques (SEM-EDX, XRD, XRF, ICP-MS) to interpret mineralogical and geochemical data.		PSO1, PSO2, PSO3, PSO4, PSO6, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Crystal chemistry: atom, atomic and ionic radii, coordination of ions, Pauling's Rules, different types of chemical bonding, crystal growth, crystal defects, external and internal symmetry, XRD: powder and single crystal diffraction. Twinning, polymorphism: types of polymorphic transformation, polytypism and pseudomorphism. Mineral stability and phase diagram, two-component eutectic systems (Di–An; Fo–Si), incongruent melting, fractional crystallization in the system, solid solution systems (Ab–An; Fo–Fa), and exsolution. Crystallization in ternary systems: Equilibrium crystallization involving binary eutectic subsystems (Ab–An–Di), systems with a congruently melting compound (Di–An–Fo; An–Al–Or), systems with an incongruently melting compound (Fo–An–Qz; Leucite in the Leucite–Nepheline–Silica system; equilibrium and fractional crystallization), and systems with binary solid solutions (diopside–enstatite–ferrosilite).	**15**	CO1	K2, K3, K4
Module 2:	Mineralogy: Mineralogy and phase transition of the mantle, Mineral evolution, biological-mineralogical interactions, medical mineralogy. Composition, structure, chemistry, and paragenesis of the mineral groups: olivine, pyroxene, amphibole, mica, feldspar, garnet, sulphide, sulphate, carbonate, and oxides. Optical	**15**	CO2	K1, K2

	mineralogy: behaviour of light in mineral, Study of isotropic and anisotropic determinative tables and mineral identification. Purpose and working principles of analytical techniques: SEM-EDX, XRD, XRF, and ICP-MS.			
Module 3:	Geochemistry: Introduction and scope of geochemistry, geochemical classification of elements, and Goldschmidt's rule for trace element substitution. Distribution and behaviour of major and trace elements and REE in igneous, sedimentary, and metamorphic processes and products. REE composition and mantle melting condition. Geochemical characteristics of magma formed in MOR settings, subduction zone settings, and intraplate tectonic settings. Introduction to isotope geochemistry: definition and types of isotopes (stable vs. radiogenic), atomic structure and isotopic notation, isotope abundance and atomic weight, and analytical techniques (TIMS, IC PMS).	**15**	CO3, CO4	K3, K4, K5
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion/ demonstration			
Text	1. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (2nd ed.). Longman Scientific and Technical. 2. Klein, C., Hurlbut, C. S., & Dana, J. D. (1999). Manual of mineralogy (after James D. Dana). John Wiley & Sons. 3. Winchell, A. N. (1991). Elements of optical mineralogy: An introduction to microscopic petrography. Wiley. 4. Nesse, W. D. (2012). Introduction to optical mineralogy (4th ed.). Oxford University Press. 5. Kerr, P. F. (1977). Optical mineralogy. McGraw-Hill Book Company. 6. Mason, B., & Moore, C. B. (1982). Principles of geochemistry (4th ed.). John Wiley & Sons. 7. Krauskopf, K. B., & Bird, D. K. (1995). Introduction to geochemistry. McGraw-Hill. 8. Klein, C., & Dutrow, B. (2007). Manual of mineral science. John Wiley & Sons. 9. Mason, B., & Moore, C. B. (1982). Principles of geochemistry. Wiley. 10. Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers. 11. White, W. M. (2014). Isotope geochemistry. Wiley. 12. Faure, G. (1986). Principles of isotope geology (2nd ed.). John Wiley & Sons. 13. Dyar, M. D., & Gunter, M. E. (2008). Mineralogy and optical mineralogy. Mineralogical Society of America. 14. Perkins, D. (2011). *Mineralogy* (3rd ed.). Pearson.			

Title of the Course	Practical of Mineralogy and Geochemistry
Course Code	GEO-5001
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to 1. Develop skills in identifying and documenting the physical and optical properties of rock-forming minerals using hand specimens and microscopes. 2. Demonstrate the operation and application of analytical instruments such as flame photometers and spectrophotometers for geochemical analyses. 3. Train students in interpreting geochemical plots and solving numerical problems related to geochemical partitioning and trace element behavior. 4. Describe geochemical processes for interpretation of trace element and REE (rare earth element) data.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Identify and describe minerals in hand specimens and using the microscope.	PSO1, PSO2, PSO6

	CO 2. Determine major and trace chemical constituents in geological samples using flame photometers and spectrophotometers		PSO1, PSO2, PSO4, PSO6	
	CO 3. Solve problems related to partition coefficients and elemental distribution.		PSO1, PSO2, PSO3, PSO4, PSO6, PSO7	
	CO 4. Analyze trace element and REE plots to understand geological processes and tectonic settings.		PSO1, PSO2, PSO3, PSO4, PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Observing and recording properties of representative minerals in hand specimens and using the microscope	**18**	CO1	K1, K2, K3, K4
Module 2:	Determination of different chemical constituents in water/soil/rock using a flame photometer and spectrophotometer. Reading of plots/graphs.	**4**	CO2	K3, K4, K5
Module 3:	Solving numerical problems on partition coefficient	**4**	CO3	K4, K6
Module 4:	Plotting and Interpreting trace element and REE data	**4**	CO3, CO4	K4, K5, K6
Pedagogy	Lectures/tutorials/assignments/field study/discussion/demonstration			
Text	1. Mackenzie, W. S. (2015). Atlas of the rock-forming minerals in thin section. Routledge. 2. Barker, A. J. (2017). A key for identification of rock-forming minerals in thin section. Wiley-Blackwell. 3. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (2nd ed.). Longman Scientific and Technical. 4. Khandpur, R. S. (2006). Handbook of analytical instruments. McGraw-Hill Education LLC. 5. Klein, C., Hurlbut, C. S., & Dana, J. D. (1999). Manual of mineralogy (after James D. Dana). John Wiley & Sons. 6. Winchell, A. N. (1991). Elements of optical mineralogy: An introduction to microscopic petrography. Wiley. 7. Nesse, W. D. (2012). Introduction to optical mineralogy (4th ed.). Oxford University Press. 8. Kerr, P. F. (1977). Optical mineralogy. McGraw-Hill Book Company. 9. Mason, B., & Moore, C. B. (1982). Principles of geochemistry. Wiley. 10. Dyar, M. D., & Gunter, M. E. (2008). Mineralogy and optical mineralogy. Mineralogical Society of America.			

Title of the Course	Structural Geology and Geotectonics
Course Code	GEO-5002
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of the course are to: 1. Describe the fundamental concepts of rock deformation and rheology, including stress-strain relationships and deformation mechanisms. 2. Analyze structural features such as faults, folds, foliations, and lineations, and interpret their kinematics and formation processes. 3. Evaluate the rheological behaviour of the lithosphere and apply microstructural observations to infer deformation conditions. 4. Apply tectonic theories to explain large-scale structural and geodynamic features of the Earth, including plate boundaries and intraplate settings.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**

	CO 1. Explain the key components of deformation and rock mechanics, including stress, strain, and rheological properties of Earth materials.		PSO 1, PSO 2	
	CO 2. Interpret structural features in rocks such as folds, faults, and shear zones using appropriate classification schemes and field-based observations.		PSO 2, PSO 3, PSO 4	
	CO 3. Assess the significance of deformation microstructures and mechanisms in understanding deformation processes and tectonic environments.		PSO 2, PSO 3, PSO 6	
	CO 4. Construct tectonic models to explain major geological structures and the dynamics of plate margins and intraplate deformation zones.		PSO 1, PSO 2, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Deformation and Rock Mechanics: Components of deformation, Strain in 1D, 2D and 3D, strain ellipsoid, Pure shear and simple shear, progressive deformation, strain analysis. Introduction to stress, deviatoric and mean stress, Mohr Circle diagram. Rheology: elastic, viscous and plastic deformation, rheologic stratification of the lithosphere. Deformation microstructures and mechanisms, recovery and recrystallization. Fractures: brittle deformation mechanisms, failure and fracture criteria, types of fractures and joints.	**15**	CO1, CO3	K2, K3, K5
Module 2:	Fault and Fold Mechanics: Faults: Characteristics of faults and fault planes, movement mechanisms, role of fluids, brittle versus ductile faults, mylonites, shear sense indicators, shear zone kinematics. Folds: Mechanisms of folding, kinematic models of folding, Ramsay's classification of folds, superposed folding, occurrence and recognition. Cleavage and foliations. Linear structures and their interpretation. An overview of structures in contractional and extensional regimes with field examples.	**15**	CO2, CO3, CO4	K3, K4, K5
Module 3:	Geotectonics: Fundamental concepts of Geotectonics, Isostasy and geoid. Continental drift, Sea floor spreading, paleomagnetism and Plate tectonics. Supercontinent cycles. Volcanic and seismic belts of the Earth. Major tectonic	**15**	CO1, CO4	K2, K3, K5

	features in intraplate settings and at convergent, divergent and transform plate margins.			
Pedagogy:	Lectures/ tutorials/ assignments/ self-study			
Text	1. Condie, K. C. (1997). *Plate tectonics and crustal evolution* (4th ed.). Butterworth-Heinemann. 2. Davis, G. H., Reynolds, S. J., & Kluth, C. F. (2011). *Structural geology of rocks and regions* (3rd ed.). Wiley. 3. Fossen, H. (2016). *Structural geology* (2nd ed.). Cambridge University Press. 4. Ghosh, S. K. (1993). *Structural geology: Fundamentals and modern developments*. Pergamon Press. 5. Hobbs, B. E., Means, W. D., & Williams, P. F. (1976). *An outline of structural geology*. Wiley. 6. Passchier, C. W., & Trouw, R. A. J. (2005). *Microtectonics*. Springer. SpringerLink 7. Pollard, D. D., & Fletcher, R. C. (2005). *Fundamentals of structural geology*. Cambridge University Press. 8. Ramsay, J. G., & Huber, M. I. (1983). *The techniques of modern structural geology: Vol. 1. Strain analysis*; *Vol. 2. Folds and fractures*. Academic Press. 9. Ramsay, J. G. (1967). *Folding and fracturing of rocks*. McGraw-Hill. 10. Turcotte, D. L., & Schubert, G. (2014). *Geodynamics* (3rd ed.). Cambridge University Press. 11. Twiss, R. J., & Moores, E. M. (2006). *Structural geology* (2nd ed.). W. H. Freeman. 12. Van der Pluijm, B. A., & Marshak, S. (2004). *Earth structure: An introduction to structural geology and tectonics* (2nd ed.). W. W. Norton & Company. 13. Frisch, W., Meschede, M., & Blakey, R. C. (2011). Plate tectonics. Continental Drift and Mountain Building. Springer Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-76504-2 14. Windley, B.F. (1996). The evolving continents. Oceanographic Literature Review, 8(43), 785.			
Web Resources:	1. https://www.iris.edu/hq/ 2. https://tectonicstudiesgroup.org/virtual-geology/ 3. https://www.earthbyte.org/ 4. https://www.earthlearningidea.com/			

Title of the Course	Practical of Structural Geology and Geotectonics
Course Code	GEO-5003
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of the course are to: 1. Demonstrate the utility of the geological maps and their interpretations, practice methods of completing outcrops and interpreting structural data in geological maps and cross-sections. 2. Train students in stereographic projection techniques and petro-fabric analysis to interpret rock deformation and field measurements. 3. Explain strain and structural geometries using field data, hand specimens, and graphical techniques. 4. Determine geological structures using satellite imagery and photographs, enhancing remote observation skills	
Course Outcomes:	At the end of the course, students will be able to:	**Mapped to PSO**
	CO 1. Interpret and complete geological outcrops and sections, integrating field data with map-based observations.	PSO 2, PSO 3, PSO 4

	CO 2. Construct and analyze stereographic projections and petro-fabric diagrams to assess structural orientation.		PSO 3, PSO 4, PSO 6	
	CO 3. Estimate strain and recognize deformation patterns from field/ microscopic data.		PSO 2, PSO 3, PSO 6	
	CO 4. Evaluate and interpret structural features using satellite imagery and remote datasets.		PSO 2, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Geological mapping and Outcrop Interpretation: • Preparation and interpretation of geological maps. • Completion of geological outcrop patterns. • Construction of geological cross-sections.	**10**	CO1	K3, K4, K5, K6
Module 2:	Field Data Recording and Graphical Techniques: • Recording structural field data (strike, dip, plunge, rake). • Plotting of field data using maps and rose diagrams. • Stereographic projection of planes and lines. • Graphical solutions to structural problems.	**10**	CO2	K3, K4, K5
Module 3:	Petro-fabric Analysis, Strain Estimation and Tectonic Interpretation: • Identification and description of mesoscopic structural features in hand specimens. • Strain estimation from field and map data (e.g., Rf/φ method, Fry method). • Study and interpretation of tectonic and structural features from satellite imagery and/or aerial photographs.	**10**	CO3, CO4	K2, K3, K5
Pedagogy:	Demonstrations /Laboratory observations / Plotting and Interpretations			
Text	1. Davis, G.H. & Reynolds, S.J. (1996). *Structural Geology of rocks and regions.* John Wiley and Sons. 2. Marshak, S., and Mitra, G. (1988). *Basic methods of Structural geology*. Prentice Hall. 3. Rowland, S.M., Duebendorfer, E. & Schiefelbein, I.M. (2007). *Structural analysis and synthesis: a laboratory course in structural geology.* Blackwell Pub.			

	4. Ramsay, J. G., & Huber, M. I. (1983). *The techniques of modern structural geology: Vol. 1. Strain analysis*; *Vol. 2. Folds and fractures*. Academic Press.
Web Resources:	https://www.iris.edu/hq/ https://tectonicstudiesgroup.org/virtual-geology/

Title of the Course	Igneous Petrology
Course Code	GEO-5004
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Describe the textures and structures of igneous rocks 2. Explain magmatic processes in different tectonic settings. 3. Discuss classifications of Igneous rocks. 4. Explain geological settings of various igneous rocks.	
Course Outcomes:	At the end of the course, students will be able to:	**Mapped to PSO**
	CO 1. Classify igneous rocks.	PSO 1, PSO 2, PSO 4, PSO 7
	CO 2. Explain the processes of formation of the rocks.	PSO 1, PSO 2, PSO 3
	CO 3. Interpret the geological settings of various types of igneous rocks.	PSO 2, PSO 4, PSO 7

	CO 4. Infer magmatic evolution of rocks.		PSO 1, PSO 3, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Magmas and Magmatic Processes; Process of formation and description of Textures and Structures of volcanic and plutonic rocks; Classification of igneous rocks: modal, chemical, quasi-chemical-schemes: their merits and demerits. Working principles of XRF and EPMA.	**15**	CO1, CO2, CO3, CO4	K1, K2
Module 2:	Composition of the mantle; Enriched- and Depleted mantle and their characteristics; Magma generation: Heat source and the factors responsible to bring about melting, Fractional melting, Batch melting and Zone melting; Magmatic Evolution; Magmatic differentiation: crystal fractionation, gravitational differentiation, flowage differentiation, filter pressing, liquid immiscibility; Magmatic assimilation, Magma mixing and contamination.	**15**	CO2, CO3, CO4	K1, K2, K3
Module 3:	Magma Associations in relation to Plate Tectonics: Alkaline rocks-Nephelinites and Ijolites, Lamprophyres and Lamproites, Carbonatites and Kimberlites; Continental flood basalts such as the Deccan Traps, Paranas, Karoo; Mid Ocean Ridge Basalts and hydrothermal activity, Ocean Island basalts, Continental as well as Ocean Arc magmatism and back arc magmatism; Alpine type intrusions and Ophiolites; Granites and Granitic rocks: I-type, S-type, A-type and M-type granites, anatexis and Granitization; Anorthosites. Continental Layered Intrusions: Mineralogical and Petrological characteristics with special reference to the Bushveld, Skaergaard, Stillwater Complexes.	**15**	CO1, CO2, CO3, CO4	K3, K4, K5
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Barker, F. (Ed.). (2013). *Trondhjemites, dacites, and related rocks*. Elsevier. 2. Best, M. G., & Christiansen, E. H. (2002). *Igneous petrology: Petrology of igneous rocks*. Wiley-Blackwell. 3. Dawson, J. B. (2012). *Kimberlites and their xenoliths* (Vol. 15). Springer Science & Business Media. 4. Middlemost, E. A. K. (1986). *Magmas and magmatic rocks: An introduction to igneous petrology*. Longman.			

	5. Moorhouse, W. W. (1959). *The study of rocks in thin sections*. Harper. 6. Philpotts, A. R., & Ague, J. J. (2022). *Principles of igneous and metamorphic petrology* (2nd ed.). Cambridge University Press. 7. Rock, N. M. S. (2013). *Lamprophyres*. Springer Science & Business Media. 8. Wager, L. R., & Brown, G. M. (1967). *Layered igneous rocks*. W. H. Freeman. 9. Williams, H., Turner, F. J., & Gilbert, C. M. (1954). *Petrography: An introduction to the study of rocks in thin sections*. W. H. Freeman. 10. Wilson, M. (Ed.). (1989). *Igneous petrogenesis*. Springer Netherlands. 11. Winter, J. D. (2013). *Principles of igneous and metamorphic petrology* (2nd ed.). Pearson Education. 12. Woolley, A. R. (2019). *Alkaline rocks and carbonatites of the world. Part 4: Antarctica, Asia and Europe (excluding the former USSR), Australasia and Oceanic Islands*. Geological Society of London.

Title of the Course	Practical of Igneous Petrology
Course Code	GEO-5005
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Describe the textures and structures of igneous rocks. 2. Train to classify the igneous rocks. 3. Discuss the processes of formation from the mineral assemblage, texture, and tectonic setting 4. Demonstrate the relationship between geochemical plots and tectonic settings	
Course Outcomes:	At the end of the course, students will be able to:	**Mapped to PSO**
	CO 1. Identify the igneous rock in hand specimen and using a microscope.	PSO 1**,** PSO 3**,** PSO 4
	CO 2. Solve CIPW Norm to determine the type of rock.	PSO 1**,** PSO 2**,** PSO 4

	CO 3. Deduce magmatic processes such as crystallization sequence, cooling rates, and magma mixing using mineral assemblage and textures.		PSO 1**,** PSO 2**,** PSO 3	
	CO 4. Infer tectonic settings based on geochemical plots		PSO 1**,** PSO 2**,** PSO 3	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Study of the textures and structures and identification of rocks in hand specimens.	**6**	CO 1, CO 2, CO 3	K1, K2, K3
Module 2:	Characterization of the following suites of rocks from micro-sections: ultramafic rocks, mafic igneous rocks, intermediate rocks, granitic rocks and alkaline igneous rocks.	**8**	CO 1, CO 3	K2, K4
Module 3:	CIPW normative calculations of minerals based on available compositional data using MS excel.	**8**	CO 1, CO 3	K3, K4, K5
Module 4:	Applications of trace elements in igneous petrology, such as spider diagrams, REE distribution patterns and implications in deducing origin, source and evolution of magma, and tectonic diagrams-trace element ratio plots.	**8**	CO 2, CO 3	K1, K2, K3, K4, K5
Pedagogy:	Lectures, problem-solving, hands-on experience in megascopic and microscopic identification of rocks and discussions.			
Text	1. Barker, F. (Ed.). (2013). *Trondhjemites, dacites, and related rocks*. Elsevier. 2. Best, M. G., & Christiansen, E. H. (2002). *Igneous petrology: Petrology of igneous rocks*. Wiley-Blackwell. 3. Dawson, J. B. (2012). *Kimberlites and their xenoliths* (Vol. 15). Springer Science & Business Media. 4. MacKenzie, W. S., Adams, A. E., & Brodie, K. H. (2017). *Rocks and Minerals in Thin Section: A Colour Atlas*. Taylor & Francis. 5. Middlemost, E. A. K. (1986). *Magmas and magmatic rocks: An introduction to igneous petrology*. Longman. 6. Philpotts, A. R., & Ague, J. J. (2022). *Principles of igneous and metamorphic petrology* (2nd ed.). Cambridge University Press. 7. Rock, N. M. S. (2013). *Lamprophyres*. Springer Science & Business Media. 8. Wager, L. R., & Brown, G. M. (1967). *Layered igneous rocks*. W. H. Freeman.			

	9. Wilson, M. (1989). *Igneous petrogenesis: A global tectonic approach* (Reprinted 2007). Springer Netherlands. 10. Winter, J. D. (2013). *Principles of igneous and metamorphic petrology* (2nd ed.). Pearson Education. *11.* Woolley, A. R. (2019). *Alaline rocks and carbonatites of the world. Part 4: Antarctica, Asia and Europe (excluding the former USSR), Australasia and Oceanic Islands*. Geological Society of London.
Web Resources:	https://www.virtualmicroscope.org/ https://www.alexstrekeisen.it/

Title of the Course	Economic Geology
Course Code	GEO-5006
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Classify different types of ore deposits 2. Explain the processes of ore mineralization 3. Discuss the distribution of ore deposits 4. Familiarize with the ore deposits of Goa	
Course Outcomes:	At the end of the course, students will be able to:	**Mapped to PSO**
	CO 1. Classify different types of ore deposits	PSO 1, PSO 2, PSO 4, PSO 7
	CO 2. Describe the processes of ore mineralization.	PSO 1, PSO 2, PSO 3
	CO 3. Identify potential ore deposits.	PSO 2, PSO 4, PSO 7

	CO 4. Describe the ore deposits of Goa		PSO 1, PSO 4, PSO 5	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction: Scope of economic geology. Mineral economics. Ore, tenor, gangue, resource, reserves, Textures and structures of the ore deposits. Classification of ore deposits.	**15**	CO1, CO2, CO3, CO4	K1, K2
Module 2:	Ore bearing fluids: Type, nature, chemistry. Physicochemical controls of ore deposition; Wall-rock alteration. Controls of ore localization. Distribution of ore deposits in relation to plate tectonic settings. Magmatic and hydrothermal deposits.	**15**	CO2, CO3, CO4	K1, K2, K3
Module 3:	Distribution, genesis and ore deposits of India: Iron ore, Manganese ore, Polymetallic ore, copper, lead, zinc, Chromite, Laterite and Bauxite, Asbestos, Barite, Gold and Diamond. Offshore and deep-sea deposits. Mineral deposits of Goa.	**15**	CO1, CO2, CO3, CO4	K3, K4, K5
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion			
Text	1. Guilbert, J. M., and Park Jr, C. F. (2007). The geology of ore deposits. Waveland Press. 2. Jensen, M. L., and Bateman, A. M. (1991). Economic Mineral Deposits 3rd edition-Revised Printing. 3. Brown, J. C., & Dey, A. K. (1976). Mineral and nuclear fuels of the Indian subcontinent and Burma. 5. Roy, B. C. (1973). Indian Mineral Resources, Industries, and Economics. Calcutta: Editions Indian. 6. Arndt, N., Kesler, S., and Ganino, C. (2015). Metals and society: An introduction to Economic geology. Springer. 7. Taylor, R. (2010). Ore textures: recognition and interpretation. Springer Science & Business Media.			

Title of the Course	Practical of Economic Geology
Course Code	GEO-5007
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	The objectives of this course are to: 1. Describe the properties of the ore minerals in hand specimen 2. Plotting ore mineral deposits on the outline map of India			
Course Outcomes:	At the end of the course, students will be able to:		**Mapped to PSO**	
	CO 1. Identify the ore minerals in hand specimen and under the microscope		PSO 1, PSO 2, PSO 4, PSO 6	
	CO 2. Locate ore mineral deposits of India.		PSO 1, PSO 2, PSO 4, PSO 6, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Study of representative ores, and industrial minerals in hand specimens.	**30**	CO1, CO2	K1, K2, K4, K6

	Preparation of charts showing the distribution of ore minerals in India. Mineralogical and textural studies of common ore minerals in incident light.			
Pedagogy:	Lectures/field study/mine visits/discussion			
Text	1. Mineral Atlas of India, Published by Geological survey of India, 2001 2. Guilbert, J. M., and Park Jr, C. F. (2007). The geology of ore deposits. Waveland Press. 3. Dixon, C. J. (Ed.). (2012). Atlas of economic mineral deposits. Springer Science & BusinesBurma. s Media. 4. Brown, J. C., & Dey, A. K. (1976). Mineral and nuclear fuels of the Indian subcontinent 5. Roy, B. C. (1973). Indian Mineral Resources, Industries, and Economics. Calcutta: Editions Indian. 6. Taylor, R. (2010). Ore textures: recognition and interpretation. Springer Science & Business Media.			

Discipline Specific Elective Courses

Title of the Course	Marine Geology
Course Code	GEO-5201
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to 1. Impart foundational knowledge of coastal processes and oceanic features. 2. Familiarize students with marine mineral resources, their genesis, classification, and economic significance. 3. Introduce techniques in marine geophysics for seabed mapping and resource exploration. 4. Understand coastal zone management, marine policies, and strategies for addressing coastal hazards and environmental concerns.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Identify key geomorphological and tectonic features of the ocean floor and coastal zones.	PSO1, PSO2, PSO4

	CO 2. Classify marine sediments and mineral resources and assess their economic potential, particularly in the Indian context.		PSO1, PSO2, PSO4, PSO6	
	CO 3. Apply basic geophysical methods for marine exploration and data analysis.		PSO1, PSO2, PSO3, PSO4, PSO6	
	CO 4. Evaluate coastal management practices and legal frameworks addressing coastal hazards, resource use, and environmental protection.		PSO1, PSO2, PSO3, PSO6, PSO7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction and scope of marine geology, coastal zone and coastline classifications, beaches, types of beaches and beach landforms, oceanic and landform features. Morphologic and tectonic domain of the ocean floor: deep ocean floor and various topographic features—ridges, seamounts, coral reefs, continental shelf, continental slope, trenches, and canyons. Origin of oceanic crust, oceanic circulation, waves and currents, pelagic sediments, abyssal plain sediments, classification of sediment, and ocean tectonics.	**15**	CO1, CO2	K1, K2, K4
Module 2:	Classification of marine mineral deposits, origin and depositional system of marine resources, beach placers, shelf deposits, phosphorites, carbonates, polymetallic nodules, gas hydrates, hydrocarbon deposits, sulphide deposits, hydrothermal deposits, reserves, and economics of marine resources with special reference to India. AI and digital technology in ocean exploration and innovation**.** Introduction to marine geophysics, methods of geophysical surveys for seabed mapping and mineral exploration. Introduction to Marine Geochemistry. Laboratory methods for sample analyses.	**15**	CO1, CO2, CO3	K2, K3, K4, K5
Module 3	Coastal zone management, coastal erosion and protection measures, coastal natural disasters and management, saltwater intrusion and submarine groundwater discharge, marine spatial planning, coastal zone regulation and acts, and the law of the seas. Coastal surveys including beach profiling, exclusive economic zones	**15**	CO4	K4, K5

	(EEZ), concept and causes of sea level changes and measurements, Introduction to paleo-beaches and the coastal tectonic framework of India.			
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion/ demonstration			
Text	1. Shepard, F. P. (1973). Submarine geology (3rd ed.). Harper & Row. 2. Kuenen, P. H. (1950). Marine geology. Wiley; Chapman & Hall. 3. King, C. A. M. (1979). Introduction to marine geology and geomorphology. The English Language Book Society. 4. Kennett, J. P. (1982). Marine geology. Prentice Hall. 5. Chester, R., & Jickells, T. D. (2012). Marine geochemistry (3rd ed.). Wiley-Blackwell. 6. Roy-Barman, M., & Jeandel, C. (2016). Marine geochemistry. Oxford University Press. 7. Jones, E. J. W. (1999). Marine geophysics. John Wiley & Sons. 8. Seibold, E., & Berger, W. H. (1982). The sea floor: An introduction to marine geology. Springer-Verlag. 9. Pipkin, B. W., Gorsline, D. S., Casey, R. E., & Hammond, D. E. (1972). Laboratory exercises in oceanography. W. H. Freeman. 10. Knauss, J. A. (2005). Introduction to physical oceanography. Orange Grove Books. (Original work published earlier) 11. Keen, M. J. (1968). The sea floor: An introduction to marine geology. Elsevier. 12. Levin, H. L. (2004). Marine geology: Exploring the new frontiers of the ocean (The Living Earth). Facts On File.			

Title of the Course	Practical of Marine Geology
Course Code	GEO-5202
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to 1. Understand the principles and functions of marine geological tools and navigation instruments. 2. Demonstrate techniques for beach profiling, coastal mapping, and marine mineral sampling. 3. Explain the methodology for analyzing marine sediments and heavy minerals. 4. Evaluate ocean floor features and tectonic settings using geomorphological and bathymetric data.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Describe the usage of GPS, compass, depth sounder, and various marine survey systems	PSO1, PSO2, PSO3,
	CO 2. Carry out beach profiling and heavy mineral separation techniques in field and lab settings.	PSO1, PSO2, PSO3, PSO4, PSO6

	CO 3. Analyze sediment samples for grain size and mineral composition through microscopy and slide preparation		PSO1, PSO2, PSO4, PSO6	
	CO 4. Interpret marine geomorphological features such as trenches, seamounts, and ridges using bathymetric maps.		PSO1, PSO2, PSO3, PSO4,	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to Marine Geological Tools: Familiarization with nautical charts and bathymetric maps, Use of GPS, compass, and depth sounder. Introduction to marine survey equipment: echo sounder, sub-bottom profiler, side-scan sonar, multibeam systems.	**4**	CO1	K1, K2, K3
Module 2:	Study of marine minerals in hand specimens and under the microscope.	**4**	CO1, CO3	K2, K3, K4
Module 3:	Beach profile mapping and beach survey. Separation and identification of heavy minerals in marine sediments; preparation and examination of smear slides.	**10**	CO2	K4, K5, K6
Module 4:	Preparation of coastal geomorphology map, ocean morphometry, resources, and tectonics. Identification of features like submarine canyons, seamounts, guyots, mid-ocean ridges, and trenches.	**12**	CO4	K2, K3, K4
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion/ demonstration			
Text	1. Kennett, J. P. (2001). *Marine geology* (2nd ed.). Upper Saddle River, NJ: Prentice Hall. 2. Pinet, P. R. (2019). *Invitation to oceanography* (8th ed.). Burlington, MA: Jones & Bartlett Learning. 3. Trujillo, A. P., & Thurman, H. V. (2020). *Essentials of oceanography* (13th ed.). New York, NY: Pearson. 4. Davis, R. A. (2012). *Principles of oceanography* (1st ed.). Boston, MA: Pearson. 5. Sharma, R. (2010). *Deep-sea mining: Resource potential, technical and environmental considerations*. Berlin: Springer. (Useful for understanding marine mineral resources and sampling techniques) 6. Seibold, E., & Berger, W. H. (1996). *The sea floor: An introduction to marine geology* (3rd ed.). Berlin: Springer-Verlag.			

	7. Emery, K. O. (1968). *The sea off southern California: A modern sedimentary environment*. New York: Wiley-Interscience.

Title of the Course	Environmental Geology
Course Code	GEO-5203
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Bachelor of Science in Geology from a UGC recognized University.	
Course Objectives:	The objectives of this course are to; 1. Understand the fundamentals of natural and man-made hazards. 2. Discuss environmental issues associated with industrialization and urbanization. 3. Apply principles of hydrology in water resource management. 4. Explain causes of pollution and discuss preventive measures.	
Course Outcomes:	At the end of the course, the student will be able to;	**Mapped to PSO**
	CO 1. Describe geological processes affecting the environment.	PSO1, PSO2
	CO 2. Identify environmental issues associated with industrialization and urbanization.	PSO1, PSO3
	CO 3. Examine hydrological processes to manage water resources.	PSO1, PSO3, PSO4

	CO 4. Evaluate causes of pollution and suggest remedial measures.		PSO1, PSO2, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Scope and concepts of environmental geology, human population growth and sustainability. Ecosystems, lithos-phere, hydrosphere, cryosphere and atmosphere. Natural and manmade hazards, risks and their mitigations: Mass movements, deforestation, volcanic eruptions, earthquakes, tsunamis, floods and droughts. Case studies	**15**	CO1	K1. K2
Module 2:	Global warming - Industrialization, urbanization, urban heat island, urban environments and their impact. Exploitation of fossil fuels. Coal mining and related hazards. Sea level changes and causative factors. Coastal processes: Natural and anthropogenic hazards and mitigation. Trace elements and their implications on health, controls on elemental intake.	**15**	CO2, CO4	KI, K2, K3
Module 3:	Impact assessment of degradation and contamination of surface and groundwater quality due to industrialization and urbanization. Organic and inorganic contamination of groundwater and its remedial measures. Geological and hydrogeological aspects of waste disposal, site selection for solid waste disposal-sanitary landfills. Surface and subsurface disposal of toxic, metallic and radioactive wastes. Planning and management of hazardous waste. Environmental legislation and EIA in India**.**	**15**	CO2, CO3, CO4.	K2, K3, K4
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Keller, E. A. (2012). *Introduction to Environmental Geology* (5thed). Prentice Hall. 2. Merrits. D., De Wet, A., & Menking, K. (1997). *Environmental Geology: an earth system science approach.* W. H. Freeman, New York. 3. Montgomery, C. W. (2020). *Environmental geology*. (11th ed). Professor Emerita, Northern Illinois University. 4. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment*. Cengage Learning. 5. Valdiya, K. S. (2013). *Environmental Geology: Ecology, Resource and Hazard Management.* McGraw-Hill Education.			

Title of the Course	Practical of Environmental Geology
Course Code	GEO-5204
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Bachelor of Science in Geology from a UGC recognized University.			
Course Objectives:	The objectives of this course are; 1. Identify distribution of natural and anthropogenic hazards prone regions in India. 2. Predicting movement of groundwater and pollutants in the subsurface			
Course Outcomes:	At the end of the course, the student will be able to;		**Mapped to PSO**	
	CO1: Identify natural and anthropogenic hazard-prone regions in India.		PSO5	
	CO 2: Plot groundwater flow and subsurface movement of pollutants.		PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**

Module 1:	Preparation of global and Indian natural hazard maps; Plotting of following on the map of India: Seismic zone, regions affected by contamination of water, soil map, landslide susceptible zones, flood prone areas, Coastal regulatory zones.	**12**	CO1, CO2, CO3, CO4.	K1, K2, K3
Module 2:	Interpretation of transport of pollutants in the subsurface based on given data. Preparation of groundwater flow nets.	**10**	CO2, CO3, CO4	K2, K3
Module 3:	Assessment of probable contaminant movement in the subsurface. Solving problems on movement of pollutants using simple computer assisted models.	**8**	CO2, CO4	K2, K3
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Keller, E. A. (2012). *Introduction to Environmental Geology* (5th). Prentice Hall. 2. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment*. Cengage Learning. 3. Montgomery, C. W. (2020). *Environmental geology*. (11th ed). Professor Emerita, Northern Illinois University			

SEMESTER II

Discipline Specific Core Course

Title of the Course	Sedimentology
Course Code	GEO-5008
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	The objectives of this course are to: 1. Explain the fundamental processes of weathering, transportation, and deposition that shape sedimentary environments. 2. Learn various sedimentary rocks, their petrographic features and provenance. 3. Study terrestrial and marine depositional environments. 4. Understand the formation, tectonic settings and evolution of sedimentary basin.

Course Outcomes:	At the end of the course, student will be able to:		**Mapped to PSO**	
	CO 1. Describe the key sedimentary processes.		PSO 1, PSO 2, PSO 3	
	CO 2. Classify sedimentary rocks based on texture, composition and petrographic characteristics.		PSO 1, PSO 2, PSO 3, PSO 6	
	CO 3. Differentiate between different terrestrial and marine depositional environments.		PSO 2, PSO 3, PSO 4, PSO 6	
	CO 4. Analyze sedimentary basin types and assess their geological significance.		PSO 1, PSO 2, PSO 3, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to sedimentology, temporal and spatial distribution of sedimentary rocks and their applications. Sedimentary processes: Weathering: Types and their products, soils and paleosols; transportation and deposition, Fundamentals of fluid flow, particle transport by fluid and by sediment gravity flows. Textures and structures of sedimentary rocks and their origin.	**15**	CO1	K1, K2, K3,
Module 2:	Sediments and Sedimentary rocks: Petrography, classification and provenance of - Terrigenous/clastic sedimentary rocks: Conglomerate, breccia, sandstones and mud rocks. Heavy minerals in clastic sediments: Mineralogy, separation techniques, and significance. Carbonate rocks: Limestones and dolomites. Evaporites, silicious, phosphatic, iron and manganese-rich sedimentary rocks and volcaniclastic sediments.	**15**	CO2	K1, K2, K3, K4, K5

	Coal, oil shale and petroleum.			
Module 3:	Depositional environments and sedimentary basins Introduction and classification: Terrestrial environment - fluvial system, eolian (desert) system, lacustrine system and glacial system. Marine environment: Deltaic system, beach and barriers island system, estuarine system, lagoonal system, tidal flat system; shelf and deep-water environment. Types of sedimentary basins.	**15**	CO3, CO4	K1, K2, K3, K4, K5
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Boggs Jr, S., and Boggs, S. (2009). *Petrology of sedimentary rocks.* Cambridge university press. 2nd Edition. 2. Boggs, S. (2006*). Principles of sedimentology and stratigraphy*. Pearson Prentice Hall. 4th Edition. 3. Collinson, J. (2006). *Sedimentary structures*. Dunedin Academic Press Ltd. 4. Çiner, A., Banerjee, S., Lucci, F., Radwan, A. E., Shah, A. A., Doronzo, D. M., ... & Bauer, W. (2023). *Recent Research on Sedimentology, Stratigraphy, Paleontology, Tectonics, Geochemistry, Volcanology and Petroleum Geology*. 5. Greensmith, J. T. (1989). *Petrology of the sedimentary rocks* (7th ed.). Unwin Hyman. 6. Nichols, G. (2009). *Sedimentology and stratigraphy*. John Wiley and Sons. 7. Pettijohn, F. J. (2004). *Sedimentary rocks* (3rd ed.). CBS Publishers. 8. Prothero, D.R. and Schwab, F. (2013). *Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy*. W.H. Freeman, 3rd Edition. 9. Selley, R. C. (2000). *Applied sedimentology*. Elsevier. 2nd Edition. 10. Sengupta, S. (2017). *Introduction to sedimentology*. Routledge. 11. Tucker, M. E., & Jones, S. J. (2023). *Sedimentary petrology*. John Wiley & Sons. 12. Tucker, M. E. (2001). *Sedimentary petrology: an introduction to the origin of sedimentary rocks*. John Wiley and Sons. 3rd Edition.			

Title of the Course	Practical of Sedimentology
Course Code	GEO-5009
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Study granulometric sieving method to understand the grain size distribution. 2. Construct paleocurrent plots to illustrate spatial sediment transport patterns. 3. Identify sedimentary rocks and their textural as well as structural features through hand specimen and thin section analysis. 4. Perform heavy mineral analysis. 5. Study core logs to infer depositional environments and provenance.	
Course Outcomes:	At the end of the course, student will be able to:	**Mapped to PSO**

	CO 1. Perform granulometric and statistical analyses on sediments.		PSO1, PSO2, PSO3, PSO4, PSO6, PSO7	
	CO 2. Interpret paleocurrent data.			
	CO 3. Classify sedimentary rocks in hand specimen and using a microscope.			
	CO 4. Analyze heavy mineral assemblages.			
	CO 5. Interpret core logs.			
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Granulometric analysis by sieving method: Textural analyses of sediments, plotting of grain size data and statistical analyses and interpretation.	**8**	CO1	K1, K2, K3, K4, K5
Module 2:	Paleocurrent analysis: Exercises using sets of directional data to understand spatial variation in vectorial data.	**4**	CO2	K1, K2, K3, K4, K5
Module 3:	Study of hand specimens: Megascopic identification of sedimentary rocks, observation of texture, structure and diagenetic changes; inferences on depositional environment.	**4**	CO3	K3, K4, K5
Module 4:	Study of thin sections: microscopic identification of sedimentary rocks, observation of texture, mineralogy and diagenetic changes.	**4**	CO3	K3, K4, K5
Module 5:	Heavy mineral separation and analysis for provenance interpretation: Sample collection and preparation, Heavy liquid separation, identification under binocular microscope and provenance interpretation using mineral assemblages.	**6**	CO4	K2, K3, K4
Module 6:	Sedimentological interpretation of core logs: Examination of sediment characteristics and variation using either existing data sets or collected sediment cores.	**4**	CO5	K2, K3, K4, K5, K6
Pedagogy:	Lectures, demonstrations, problem-solving, hands-on experience in megascopic and microscopic identification of rocks			

	and discussions.
Text	1. Adams, A. E., MacKenzie, W. S., and Guilford, C. (2017). *Atlas of sedimentary rocks under the microscope*. Routledge. 2. Blatt, H., Middleton, G.V. and Murray, R.C. (1980): *Origin of Sedimentary Rocks*, Prentice-Hall Inc. 3. Boggs Jr, S., and Boggs, S. (2009). *Petrology of sedimentary rocks.* Cambridge University Press. 2nd Edition. 4. Boggs, S. (2006*). Principles of sedimentology and stratigraphy*. Pearson Prentice Hall. 4th Edition. 5. Collins, J.D., and Thompson, D.B. (1982): *Sedimentary Structures*. George Allen & Unwin, London. 6. Lindholm, R.C. (1987) *A Practical Approach to Sedimentology*. Allen & Unwin, London. 7. Prothero, D.R. and Schwab, F. (2013*). Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy*. W.H. Freeman, 3rd Edition. 8. Reineck, H.E. and Singh, I.B. (1973): *Depositional Sedimentary Environments.* Springer-Verlag. 9. Selley, R. C. (2000). *Applied sedimentology*. Elsevier. 2nd Edition. 10. Tucker, M. E. (2001). *Sedimentary petrology: an introduction to the origin of sedimentary rocks.* John Wiley and Sons. 3rd Edition. 11. Tucker, M. E. (2011). *Sedimentary rocks in the field: a practical guide* (Vol. 38). John Wiley and Sons. 12. Tucker, M. E., & Jones, S. J. (2023). *Sedimentary petrology: An introduction* (4th ed.). Wiley. 13. Tucker, M.E. (1990): *Carbonate Sedimentology*, Blackwell Scientific Publication.

Title of the Course	Metamorphic Petrology
Course Code	GEO-5010
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Understand the types, facies, textures, and field characteristics of metamorphic rocks and the factors influencing metamorphism. 2. Learn and apply thermodynamic principles to interpret equilibrium conditions and phase relations in metamorphic systems. 3. Study metamorphic reactions and employ chemographic diagrams to understand progressive metamorphism in different rock types. 4. Understand metamorphic petrology concepts with reference to plate tectonic settings and geodynamic processes.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Interpret the types, facies, and textures of metamorphic rocks and their formation.	PSO 1, PSO 2

	CO 2. Apply thermodynamic principles to metamorphic phase equilibria and geothermobarometry.		PSO 1, PSO 3, PSO 6	
	CO 3. Interpret metamorphic reactions and chemographic projections of various lithologies.		PSO 2, PSO 3, PSO 6	
	CO 4. Evaluate the relationship between metamorphism and plate tectonics and its implications for crustal processes.		PSO 1, PSO 2, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Types, Facies and Textures of metamorphic rocks: Definitions, factors and conditions of metamorphism; pressure and temperature limits of metamorphism; Types of metamorphism - orogenic, ocean-floor, regional, contact, cataclastic, hydrothermal, and other types of small-scale metamorphism. Facies and facies series; Zones of Metamorphism; Concept and origin of isograds; General characteristics of contact and regional metamorphic rocks; Classification and types of textures; Interpretation of porphyroblast–inclusion relations.	**15**	CO1, CO4	K2, K5
Module 2:	Thermodynamics Related to Mineral Science: Concept of equilibrium in metamorphic systems; Gibbs phase rule and mineralogical phase rule and their application in simple and complex systems. First law of thermodynamics, second law of thermodynamics—definition of entropy, third law of thermodynamics, thermodynamic equations, free energy of formation of minerals at any temperature and pressure, free energy surface in G–T–P–X space, free energy of ideal and non-ideal solutions, the regular solution model, equilibrium constant of a reaction and its relation with Gibbs free energy. Geothermmetry.	**15**	CO2	K2, K3, K4
Module 3:	Metamorphic Reactions, Chemographic Projections and Progressive metamorphism in pelitic, carbonate and mafic rocks: Different types of metamorphic reactions, reactions among solid phase components, reactions involving	**15**	CO2, CO3, CO4	K3, K4, K5

	volatiles as reacting species, controls of pressure, temperature and chemical compositions on the metamorphic reactions, time scale of metamorphism; ACF, AKF and AFM diagrams; Progressive metamorphism in pelitic, carbonate and mafic rocks; Metamorphism in the context of plate tectonics.			
Pedagogy:	Lectures/ tutorials/ assignments.			
Text	1. Winter, J. D. (2010). *An Introduction to Igneous and Metamorphic Petrology (2nd Edition)*, Pearson Education, Inc. 2. Philpotts, A., & Ague, J. (2009). *Principles of Igneous and Metamorphic Petrology (2nd ed.)*. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511813429. 3. Bucher, K., & Grapes, R. (2011). *Petrogenesis of Metamorphic Rocks (8th Edition)*, Springer. 5. Best, M. (2002). *Igneous and Metamorphic Petrology (2nd Edition).* Blackwell Science Ltd. 6. Frost, R., and Frost, C., (2014). *Essentials of Igneous and Metamorphic Petrology*. Cambridge University Press, New York. 7. Vernon, R., (2018). *A Practical Guide to Rock Microstructure (2nd Ed.),* Cambridge University Press, https://doi.org/10.1017/9781108654609. 8. Winkler, H.G.F., (1979). *Metamorphic Petrogenesis (5th Ed.).* Springer Verlag, New York. 9. Spear, F., (1993). *Metamorphic Phase Equilibria and Pressure Temperature-Time Paths.* Mineralogical Society of America, Washington, D.C.			
Web Resources:	https://www.virtualmicroscope.org/ https://atlas-of-metamorphic-minerals.netlify.app https://www.perplex.ethz.ch/ https://www.gplates.org/			

Title of the Course	Practical of Metamorphic Petrology
Course Code	GEO-5011
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Learn to identify common metamorphic minerals and rocks in hand specimens and thin sections. 2. Understand and apply techniques for calculating ionic radius ratios and mineral structural formulae. 3. Study metamorphic rocks based on mineral assemblages, textures, and fabric both macroscopically and microscopically. 4. Impart skills of correlating the mineralogy and texture with metamorphic conditions and processes.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Classify common metamorphic minerals in hand specimens and using a microscope.	PSO 1, PSO 2, PSO 4

	CO 2. Calculate ionic radius ratios and derive structural formulae of commonly occurring metamorphic minerals.		PSO 1, PSO 3, PSO 6	
	CO 3. Classify metamorphic rocks based on mineral assemblages, texture, and fabric observed under the microscope and in hand specimen.		PSO 2, PSO 3, PSO 6	
	CO 4. Interpret metamorphic conditions and rock histories based on mineralogy and textural relationships.		PSO 1, PSO 2, PSO 7	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Identification of typical metamorphic minerals in hand specimen and thin section.	**6**	CO1	K2
Module 2:	Calculation of ionic radius ratios in common silicate crystal structures. Calculation of structural formulae of commonly occurring minerals	**6**	CO2	K2, K3
Module 3:	Description, identification and classification of commonly occurring metamorphic rocks and their fabrics and textures in hand specimen	**8**	CO3, CO4	K3, K4, K5
Module 4:	Description, identification, and classification of commonly occurring metamorphic rocks and their fabrics and textures in thin section.	**10**	CO3, CO4	K3, K4, K5
Pedagogy:	Demonstrations /Laboratory observations / Plotting and Interpretations.			
Text	1. Yardley, B. W., MacKenzie, W. S., and Guilford, C. (1997). *Atlas of metamorphic rocks and their textures*. Longman. 2. Vernon, R. H. (2018). *A practical guide to rock microstructure*. Cambridge University Press. 3. Dana, E. S., and Ford, W. E. (1952). *Dana's textbook of mineralogy*. Wiley Easstern Limited 4. Winter, J. D. (2010). *An Introduction to Igneous and Metamorphic Petrology (2nd Edition)*, Pearson Education, Inc. 5. Phillips W. R. and Griffen, D.T. (1981). *Optical Mineralogy: The Non-opaque Minerals*. W. H. Freeman and Co., Ltd. New York.			

Web Resources:	https://www.virtualmicroscope.org/ https://atlas-of-metamorphic-minerals.netlify.app https://www.alexstrekeisen.it/

Title of the Course	Stratigraphy and Indian Geology
Course Code	GEO-5012
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Describe key concepts of stratigraphy and their applications. 2. Understand sedimentary sequences and recognize the depositional environment. 3. Learn to relate geological events with stratigraphic records of India. 4. Explain various stratigraphic units with their present geographic locations.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Apply key concepts of stratigraphy for constructing stratigraphic sequences.	PSO1, PSO2
	CO 2. Interpret sedimentary sequences.	PSO1, PSO3

	CO 3. Correlate geological events with stratigraphic sequences of India.		PSO3, PSO4	
	CO 4. Categorize various stratigraphic units with their geographic locations.		PSO1, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Stratigraphic principles and their applications. Stratigraphic (Lithostratigrapic, Chronostratigraphic and Biostratigraphic) nomenclature and their inter-relationships. Depositional systems and system tracts. Palaeomagnetism and time correlation. Concepts of Magnetostratigraphy, Seismic stratigraphy, Chemostratigraphy and event stratigraphy.	**15**	CO1	K1. K2
Module 2:	Cratons and mobile belts, Archaean-Proterozoic boundary. Important Proterozoic basins of India. Precambrian/Cambrian boundary. Palaeozoic rocks in Himalayas. Mesozoic of Peninsular and Extra-Peninsular India. K-T boundary. Paleocene-Eocene Thermal Maxima (PETM), Cenozoic successions, Quaternary and Holocene stratigraphy.	**15**	CO2, CO4	KI, K2, K3
Module 3:	Important Stratigraphic Units of India: Stratigraphy of Gondwana Supergroup with special emphasis on fossils, climate and economic minerals. Deccan Volcanic Province: its distribution and lithological characteristics. Siwalik: Basin evolution, stratigraphy, and significant vertebrate fauna. Geology of Goa.	**15**	CO2, CO3, CO4.	K2, K3, K4, K5
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Ramakrishnan, M., and Vaidyanadhan, R. (2010). Geology of India (vol. 1 and 2). *GSI Publications*, *2*(1). 2. Miall, A. D. (2010). *The geology of stratigraphic sequences*. Springer Science & Business Media. 3. Babin, C. (1996). Global events and event stratigraphy in the phanerozoic. *Geobios*, *29*(3). 4. Catuneanu, O. (2022). *Principles of sequence stratigraphy*. Newnes. 5. Brookfield, M. E. (2008). *Principles of stratigraphy*. John Wiley & Sons. 6. Dessai, A.G. (2018) *Geology and Mineral resources of Goa*. New Delhi Publishers. 7. Dessai, A. G. (2023). *Environment, resources and sustainable tourism: Goa as a case study*. Springer Nature. 8. Salvador, A. (Ed.). (1994). *International stratigraphic guide: a guide to stratigraphic classification, terminology, and procedure* (No. 30). Geological Society of America.			

	9. Saha, S., Das, S. S., Mondal, S., Banerjee, S., & Sarkar, S. (2021). *Mesozoic Stratigraphy of India*. A Multi-proxy Approach.

Title of the Course	Practical of Stratigraphy and Indian Geology
Course Code	GEO-5013
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	The objectives of this course are to; 1. Understand the stratigraphic subdivisions and important geological formations in India. 2. Learn to prepare geological sections and correlate lithologic data.			
Course Outcomes:	At the end of the course, the student will be able to:		**Mapped to PSO**	
	CO 1. Plot stratigraphic subdivisions and important geological formations in India.		PSO1, PSO3	
	CO 2. Draw geological sections and correlate lithologic data.		PSO3, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**

Module 1:	Exercises on stratigraphic classification and correlation. Preparation of stratigraphic range charts.	**8**	CO1, CO2, CO3, CO4.	K1. K2, K3
Module 2	Study of rocks in hand specimens from Indian stratigraphic horizons and type localities.	**10**	CO2, CO3, CO4	K2, K3, K4
Module 3	Study of the geological maps of India and identification of major stratigraphic units. Locating/drawing of stratigraphic units on the outline map of Goa and India.	**12**	CO2, CO3, CO4	K2, K3, K4
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Ramakrishnan, M., and Vaidyanadhan, R. (2010). Geology of India (Vol. 1 and 2). *GSI Publications*, *2*(1). 2. Brookfield, M. E. (2008). *Principles of stratigraphy*. John Wiley & Sons. 3. Salvador, A. (Ed.). (1994). *International stratigraphic guide: a guide to stratigraphic classification, terminology, and procedure* (No. 30). Geological Society of America. 4. Babin, C. (1996). Global events and event stratigraphy in the phanerozoic. *Geobios*, *29*(3).			
Web Resources:	https://www.gsi.gov.in			

Title of the Course	Geological Field Mapping
Course Code	GEO-5014
Number of Credits	01
Theory/Practical	Theory
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Learn to use clinometer and brunton compass. 2. Understand the lithology, structure and their position in stratigraphic succession. 3. Learn to construct stratigraphic sequence. 4. Learn techniques of field mapping.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Identify geological features, minerals, rocks and structures in the field.	PSO1
	CO 2. Use techniques of field mapping.	PSO1, PSO2, PSO4

	CO 3. Undertake independent field mapping		PSO3, PSO4, PSO6,	
	CO 4. Prepare geological maps.		PSO1, PSO4	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Unit/Module 1:	Use of clinometer and brunton compass. Use of GPS, DGPS, GNSS for spatial data collection. Techniques of field mapping. Techniques of field data collection. Recording the attitude of beds, foliation, lineation, joints and their analysis. Introduction to the stratigraphy of the study area.	**15**	CO1, CO2, CO3, CO4	K2, K3, K4
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Dessai, A. G. (2023). *Geology and environment of Goa*. Qurate Publishers 2. Dessai, A.G. (2018) *Geology and Mineral resources of Goa*. New Delhi Publishers. 3. Mehr S.S. (1991) *Geology of Gujarat.* Geological Society of India 4. Radharishnan, B.P. and Vaidhyanadhan R., (1977) *Geology of Karnataka.* Geological Society of India. *5.* Raman, P.K. and Murty, V. N. (2012). *Geological Society of India.* 6. Roy, A. B., & Jakhar, S. R. (2002). *Geology of Rajasthan (Northwest India) precambrian to recent*. Scientific Publishers. 7. Sinha-Roy, S. (2004). Precambrian Terranes of Rajasthan, India. *Sediment Hosted Lead-Zinc Sulphide Deposits*, 222.			
Web Resources:	https://www.gsi.gov.in			

Title of the Course	Practical of Geological Field Mapping
Course Code	GEO-5015
Number of Credits	03
Theory/Practical	Practical
Level	500
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Provide hands-on experience in the field. 2. Understand the lithology, structure, and their position in stratigraphic succession. 3. Understand the importance of working as a team. 4. Learn to construct a stratigraphic sequence. 5. Learn techniques of field mapping.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO1: Identify geological features, minerals, rocks and structures in the field.	PSO1,

	CO2: Use techniques of field mapping.		PSO1, PSO2, PSO4	
	CO3: Undertake independent field mapping		PSO3, PSO4, PSO6	
	CO4: Prepare geological maps		PSO1, PSO4	
	CO5: Prepare a detailed technical report of the study area.		PSO1, PSO2, PSO6, PSO7	
Content:		**No. of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Techniques of geological mapping, field data collection: recording the attitude of beds, foliation, lineation, joints, and their analysis.	**30**	CO1, CO2, CO3, CO4	K2, K3, K4
Module 2:	Use of GPS, GNSS for spatial data collection. Sampling of rocks, preparation of geological field report.	**30**	CO1, CO2, CO3, CO4	K2, K3, K4, K5, K6
Module 3:	Preparation of map and technical report. Note 1: The record of data will be maintained in a field diary. Note 2: Fieldwork will be carried out under the supervision of teachers who will accompany the students during the course of the field traverse. Note 3: There will be a viva voce examination based on the field report.	**30**	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
Pedagogy:	Fieldwork, lectures, case studies, discussions, and assignments.			
Text	1. Dessai, A. G. (2023). *Geology and environment of Goa*. Qurate Publishers 2. Dessai, A. G. (2018). *Geology and Mineral Resources of Goa*. New Delhi Publishers. 3. Merh, S. S. (1995). *Geology of Gujarat*. Geological Society of India. 4. Radhakrishna, B. P., & Vaidyanadhan, R. (1997). *Geology of Karnataka* (2nd rev. and enl. ed.). Geological Society of India. 5. Sinha-Roy, S., Malhotra, G., & Mohanty, M. (1998). *Geology of Rajasthan*. Geological Society of India. 6. Roy, A. B., & Jakhar, S. R. (2002). *Geology of Rajasthan (Northwest India): Precambrian to Recent*. Scientific Publishers.			

	7. Ramam, P. K., & Murty, V. N. (1997). *Geology of Andhra Pradesh*. Geological Society of India. 8. Biswas, S. K., Mahender, K., & Chauhan, G. D. (2021). *Field Guide Book of Geology of Kutch (Kachchh) Basin, Gujarat, India*. Springer International Publishing. 9. Deshpande, G. G., & Pitale, U. L. (2014). *Geology of Maharashtra* (2nd ed.). Geological Society of India.
Web Resources:	https://www.gsi.gov.in

Discipline Specific Elective Courses

Title of the Course	Exploration Geophysics
Course Code	GEO-5205
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Describe the use of geophysical instruments and methods in subsurface exploration. 2. Understand the application of seismic methods, well logging techniques, and airborne geophysical methods and data corrections. 3. Understand the application of gravity, magnetic, and GPR methods and data corrections. 4. Learn to interpret geophysical data.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO1. Use various geophysical techniques	PSO 1**,** PSO 2

	CO2. Use various geophysical instruments.		PSO 6	
	CO3. Record geophysical data.		PSO 2**,** PSO 6	
	CO4. Interpret geophysical data.		PSO 3**,** PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to exploration geophysics: Electromagnetic spectrum, usefulness of various methods, Electrical methods: instrumentation, field procedure and interpretation using electrical methods. Electrical profiling and sounding using Wenner and Schlumberger configurations. Principles and fundamental procedures of data collection and interpretation.	**15**	CO 1, CO 2, CO 4	K1, K2, K3, K4
Module 2:	Seismic Methods: Principles, instrumentation, survey procedures and interpretation using seismic methods: terrestrial and marine surveys. Correction applied to seismic data. Geophysical well logging: Introduction well logging methods, porosity logs, well log interpretation. Techniques commonly used in hydrocarbon exploration. Airborne geophysical methods using drones and helicopters.	**15**	CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Module 3:	Gravity and Magnetic methods: Principles-field methods gravimeters-corrections, interpretation of gravity data. Principles, instrumentation, field procedures, data analysis and interpretation of magnetic data. Principles and field application of Ground Penetrating Radar (GPR) for sub-surface studies. Data analysis and interpretation.	**15**	CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Lectures, case studies, discussions and assignments.			
Text	1. Kearey, P., Brooks, M., & Hill, I. (2002). *An introduction to geophysical exploration* (3rd ed.). Wiley-Blackwell. 2. Lowrie, W., & Fichtner, A. (2020). *Fundamentals of geophysics*. Cambridge university press. 3. Mussett, A. E., Khan, M. A., & Button, S. (2000). *Looking into the Earth: An introduction to geological geophysics*. Cambridge University Press.			

	5. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics* (2nd ed.). Cambridge University Press. 6. William, L. (2007). *Fundamentals of geophysics.* Cambridge University Press
Web Resources:	https://www.usgs.gov https://www.gsi.gov.in

Title of the Course	Practical of Exploration Geophysics	
Course Code	GEO-5206	
Number of Credits	01	
Theory/Practical	Practical	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Describe various method of Geophysical exploration. 2. Learn to use geophysical instruments. 3. Learn to record data. 4. Learn to interpret geophysical data.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO1: Use the geophysical instruments.	PSO 1**,** PSO 2**,** PSO 6
	CO2: Select appropriate instruments for geological investigation.	PSO 2**,** PSO 4**,** PSO 6

	CO3: Record data collected through geophysical methods		PSO 3, PSO 6	
	CO4: Interpret the data.		PSO 2, PSO 3, PSO 6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Field survey using resistivity methods. problem solving and interpretation of resistivity data using master curves matching and digital techniques	15	CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Module 2:	Seismic refraction and reflection; magnetometers and gravimeter, GPR, well logs application and data interpretation for hydrocarbon exploration, mineral exploration, structural and geotechnical studies.	15	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Case studies, discussions, hands on experience in data interpretation			
Text	1. Kearey, P., Brooks, M., & Hill, I. (2002). *An introduction to geophysical exploration* (3rd ed.). Wiley-Blackwell. 2. Lowrie, W., & Fichtner, A. (2020). *Fundamentals of geophysics*. Cambridge university press. 3. Loke, M. H. (2011). *Electrical imaging surveys for environmental and engineering studies: A practical guide to 2D and 3D surveys*. Geotomo Software. 4. Mussett, A. E., Khan, M. A., & Button, S. (2000). *Looking into the Earth: An introduction to geological geophysics*. Cambridge University Press. 5. Shearer, P. M. (2009). *Introduction to seismology* (2nd ed.). Cambridge University Press. 6. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics* (2nd ed.). Cambridge University Press. 7. William, L. (2007). *Fundamentals of geophysics.* Cambridge University Press			
Web Resources:	https://www.usgs.gov https://www.gsi.gov.in https://www.sciencedirect.com			

Title of the Course	Petroleum Geology
Course Code	GEO-5207
Number of Credits	03
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to: 1. Understand the fundamentals of petroleum geology, including historical evolution, global petroleum distribution, and categorization of Indian petroliferous basins. 2. Explain the physical, chemical, and optical properties of petroleum and their implications for petroleum exploration and processing. 3. Learn the theories of petroleum origin, migration, and accumulation. 4. Learn geological and geophysical methods in petroleum exploration.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Describe the origin, types, global distribution of petroleum and the petroliferous basins of India.	PSO1, PSO2, PSO4

	CO 2. Analyze the geochemical and geological processes involved in the formation, transformation, and accumulation of hydrocarbons.		PSO1, PSO2, PSO4, PSO6	
	CO 3. Evaluate different migration mechanisms and reservoir characteristics for identifying suitable hydrocarbon traps.		PSO1, PSO2, PSO3, PSO4, PSO6	
	CO 4. Recommend suitable exploration strategies.		PSO1, PSO2, PSO3, PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Introduction to petroleum Geology, petroleum system, historical review of petroleum, and global petroleum scenario. Categorization of petroliferous basins of India. Chemical composition of petroleum: organic and inorganic compounds. Physical properties of petroleum: colour, odour, density, specific gravity, API value, volume, boiling point, cloud point, pour points, flash point, and fire point. Optical properties: Fluorescence, refractive index, optical activity. Occurrences of petroleum: surface and subsurface occurrences. Origin of Petroleum: Inorganic Hypothesis—Theory of Cosmic Origin, Theory of Magmatic Origin/Hydrocarbon in Igneous Rock as Evidence, and Mantle Degassing. Problems with inorganic theories. Genesis of Petroleum by Fischer-Tropsch Synthesis.	**15**	CO1, CO2	K1, K2, K4
Module 2:	Organic origin of hydrocarbons: diagenesis, catagenesis, metagenesis, and metamorphism. Production and composition of organic matter: geological facts, chemical facts, compelling reasons for organic origin of petroleum, similarity in chemical composition of biomass and petroleum. Production of organic matter: factors influencing primary productivity, Chemical constituents in organic matter. Accumulation of organic matter: sedimentation of organic matter, factors determining organic carbon contents in marine sediments - hydrographical, biological, chemical, geological.	**15**	CO1, CO2, CO3	K2, K3, K4, K5

	Favorable depositional conditions; role of dissolved and particulate organic matter; accumulation mechanism of sedimentary organic matter. Transformations of organic matter and formation of kerogen: Significance and main steps of early transformations, biochemical degradation, microbial activity, polycondensation, insolubilization, kerogen, and factors influencing maturation of kerogen.			
Module 3:	Migration: types of migration, primary migration, physicochemical aspects of primary migration, possible mode of primary migration, and geological and geochemical aspects of primary migration. Secondary migration, Buoyancy and Capillary Pressures, Hydrodynamics and secondary migration, Geological and geochemical implications of secondary migration, termination of secondary migration, and accumulation of oil and gas; distance of secondary migration. Reservoir: porosity, permeability, relationship between porosity, permeability, and texture, effects of diagenesis on reservoir quality, reservoir continuity, reservoir characterization, reserve calculations, and production methods. Traps and Seals: Types of traps and their classification — structural, stratigraphic, hydrodynamic, diapiric, combination, and astrobleme traps. Drilling: cable tool drilling and rotary drilling; formation evaluation; electric log, spontaneous potential log, resistivity log; radioactivity log gamma-ray, neutron, and density logs. Petroliferous basins of India: categories and potential. Krishna-Godavari basin, Mumbai offshore, Cambay basin, Rajasthan, Assam-Arakan fold belt, oil belts of the world.	**15**	CO4	K4, K5
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion/ demonstration			
Text	1. Selley, R.C., (1998). Elements of Petroleum Geology: W.H. Freeman & Company, New York. 2. Levorsen, A.I. (1967). Geology of Petroleum: W.H. Freeman and Company. 3. Tissot, B. P., & Welte, D. H. (1984). Petroleum formation and occurrence (2nd ed.). Springer-Verlag. 4. Hyne, N. J. (2012). Nontechnical guide to petroleum geology, exploration, drilling, and production (3rd ed.). PennWell Books. 5. Barker, C. (Ed.). (1996). Organic Geochemistry (Vol. 1). American Association of Petroleum Geologists (AAPG). 6. Sellami, A., & Rahmouni, A. (2022). Petroleum geology: Basin systems and models. Springer. 7. North, F. K. (1985). Petroleum geology. Allen & Unwin.			

	8. Bjorlykke, K. (2015). Petroleum geoscience: From sedimentary environments to rock physics (2nd ed.). Springer. 9. Ravi, R. (2014). Petroleum systems of India: Onshore basins. Geological Society of India. 10. Biswas, S. K. (1993). Tectonic framework, structure and petroleum prospects of Cambay Basin, western India. Journal of the Geological Society of India, 41, 325–346.

Title of the Course	Practical of Petroleum Geology
Course Code	GEO-5208
Number of Credits	01
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The objectives of this course are to 1. Understand the application of the three-point method in determining subsurface geological structures. 2. Develop skills to interpret subsurface data and construct structural contour maps for hydrocarbon exploration. 3. Learn methods for calculating porosity and permeability of the reservoirs. 4. Learn to assess geophysical well logs for lithology, fluid content, and hydrocarbon potential in sedimentary basins.	
Course Outcomes:	At the end of the course, the student will be able to:	**Mapped to PSO**
	CO 1. Apply the three-point problem method to borehole data for determining strike and dip of subsurface formations.	PSO1, PSO2, PSO4

	CO 2. Analyze well log data to differentiate between lithologies, identify fluid types, and delineate hydrocarbon-bearing zones.		PSO1, PSO2, PSO4, PSO6	
	CO 3. Evaluate porosity and permeability data to assess reservoir rock characteristics and predict fluid flow behaviour.		PSO1, PSO2, PSO3, PSO4, PSO6	
	CO 4. Construct and interpret structural contour maps using subsurface geological data to identify potential hydrocarbon traps.		PSO1, PSO2, PSO3, PSO6	
Content:		**No of hours**	**Mapped to CO**	**Cognitive Level**
Module 1:	Three-Point Problems in Borehole Data Analysis: Application of the three-point method to determine the attitude (strike and dip) of subsurface geological layers using borehole information.	**6**	CO1, CO2	K1, K2, K4, K6
Module 2:	Interpretative Contouring Techniques: Use of subsurface data to create structural contour maps for identifying the depth and geometry of oil-bearing horizons.	**6**	CO4	K2, K3, K4, K5, K6
Module 3:	Porosity and Permeability Calculations: Solving numerical problems related to primary and secondary porosity, effective and total porosity, and permeability of reservoir rocks.	**6**	CO3	K4, K5
Module 4:	Proliferous Basin Mapping and Evaluation: plotting major proliferous basins on the map of India and evaluating them based on geological setting, stratigraphy, and hydrocarbon potential.	**6**	CO2, CO4	K2, K3, K4
Module 5:	Well Log Interpretation: Analysis of well logs (e.g., gamma ray, resistivity, sonic, density, and neutron logs) for lithology identification, fluid content estimation, and delineation of hydrocarbon zones.	**6**	CO2, CO4	K3, K4, K5, K6
Pedagogy:	Lectures/ tutorials/assignments/field study/discussion/ demonstration			

Text	1. Selley, R. C. (1998). Elements of petroleum geology. W. H. Freeman & Company. 2. Tissot, B. P., & Welte, D. H. (1978). Petroleum formation and occurrence: A new approach to oil and gas exploration. Springer-Verlag. 3. Levorsen, A. I. (1967). Geology of petroleum. W. H. Freeman and Company. 4. North, F. K. (1986). Petroleum geology (p. 607). Allen & Unwin.Allen, P. A., & Allen, J. R. (2013). Basin analysis: Principles and application to petroleum play assessment (3rd ed.). Wiley-Blackwell. 5. Hyne, N. J. (2018). Nontechnical guide to petroleum geology, exploration, drilling, and production (4th ed.). PennWell Corporation. 6. Gluyas, J., & Swarbrick, R. (2021). Petroleum geoscience (3rd ed.). Wiley-Blackwell. 7. Mann, R. (2022). Practical petroleum geology. Springer.