



UNIVERSITY OF ALLAHABAD

(A CENTRAL UNIVERSITY)

PRAYAGRAJ, UTTAR PRADESH - 211002

CURRICULUM

GEOLOGY HONOURS

(APRIL 2026)

BACHELOR OF SCIENCE

(AS PER NATIONAL EDUCATION POLICY - 2020)



Curriculum Structure for Geology (Major)

Semester	Discipline Specific Core	Theory (L+T)			Practical	
		Credits	Marks		Credits	Marks
			External	Internal		
1	Physical Geology (GC11)	2	35	15		
	Structural Geology (GC12)	2	35	15		
	Introduction to Geophysics (GC13)	2	35	15		
	Structural Geology (GP11)				1	25
	Geological Field Work-I (GP12)				1	25
2	Crystallography (GC21)	2	35	15		
	Mineralogy (GC22)	2	35	15		
	Igneous Petrology (GC23)	2	35	15		
	Crystallography and Mineralogy (GP21)				1	25
	Petrology-I (GP22)				1	25
3	Sedimentology (GC31)	2	35	15		
	Metamorphic Petrology (GC32)	2	35	15		
	Geo-tectonics (GC33)	2	35	15		
	Petrology-II (GP31)				1	25
	Geological Field Work-II (GP32)				1	25
4	Stratigraphy (GC41)	2	35	15		
	Paleontology (GC42)	2	35	15		
	Computer Programming in Geosciences (GC43)	2	35	15		
	Computer Programming in Geosciences (GP41)				1	25
	Paleontology (GP42)				1	25

Curriculum Structure for Geology (Minor)

Semester	Minor Course	Theory (L+T)			Practical	
		Credits	Marks		Credits	Marks
			External	Internal		
1	Physical Geology (GM11)	1	20	20		
	Structural Geology (GM12)	1	20			
	Introduction to Geophysics (GM13)	1	20			
	Practical-I (GMP1)				1	20
2	Crystallography (GM21)	1	20	20		
	Mineralogy (GM22)	1	20			
	Igneous Petrology (GM23)	1	20			
	Practical-II (GMP2)				1	20
3	Sedimentology (GM31)	1	20	20		
	Metamorphic Petrology (GM32)	1	20			
	Geo-tectonics (GM33)	1	20			
	Practical-III (GMP3)				1	20
4	Stratigraphy (GM41)	1	20	20		
	Paleontology (GM42)	1	20			
	Computer Programming in Geosciences (GM43)	1	20			
	Practical-IV (GMP4)				1	20

GEOLOGY MAJOR (SEMESTER-I)

GC11: PHYSICAL GEOLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The paper introduces the earth sciences and its attributes. The paper discusses popular hypothesis for the genesis/development process of the earth and the solar system. It also outlines different earth shaping agents working on the surface and in the sub-surface. The paper comprehends major rock forming processes and their relationship with current continental distribution over the crust.

Syllabus

Unit	Course Content
I	Introduction: Geology and its branches; concept of isostasy and continental drift theory; Earth as a planet: The solar system; Modern theories on the origin of the Earth and other planetary bodies; Space and time scales of processes in the solid Earth, atmosphere and oceans; and evolutionary parameters.
II	Earth as a planet: Composition of the earth; interior of the earth; age of the earth; elements of geological timescale, rock record and major events in the earth's history; matter and energy of the earth; earth's magnetism and gravity; Origin of hydrosphere and atmosphere.
III	Earth Surface Processes: Concept of erosion cycles; Weathering, Exhumation (Erosional and Tectonic) and soil formation; natural water and rock cycle.
IV	Erosional Landforms: Erosional landforms formed by the geological action of river, wind, glacier, sea and volcanism; Karst topography. Processes of rock formation.

Texts / Reference Books

1. Anderson R.S. and Anderson S.P. (2010): Geomorphology: The Mechanics and Chemistry of Landscapes. Cambridge University Press, 637pp. ISBN: 978-0-521-51978-6.
2. Das B.C., Ghosh s. and Islam A. (2019): Quaternary Geomorphology in India: Case Studies from the Lower Ganga Basin. Springer International Publishing, 224p. ISBN: 978-3-319-90426-9, 978-3-319-90427-6.
3. Emiliano, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
4. Holmes, Arthur (2016): Principles of Physical Geology (3rd Edition). Thomas Nelson and Sons Ltd., London (also available in paperback of 1978 edition), 628p. ISBN: 978-0471072515.
5. Leet L.D., Judson S. and Kauffman M.E. (1978): Physical Geology (5th Edition), Prentice Hall, 496p. ISBN: 978-0136697398.
6. Ritter D.F., Kochel R.C. and Miller J.R. (2006): Processes of Geomorphology (4th Edition). Waveland Press, 560p. ISBN: 978-1577664611.
7. Rosgen D. (1996): Applied River Morphology (2nd Edition). Wildland Hydrology Publishers, 386p. ISBN: 978-0965328906.
8. Summerfield M.A. (1991): Global geomorphology: An introduction to the study of landforms. Longman Scientific and Technical, 547p. ISBN: 0-582-30156-4.

Learning Outcomes

- CO1.** Theories related to the genesis of the earth and its association with other planetary bodies of the solar system. (Knowledge Level: Remembering & Understanding)
- CO2.** Understanding of earth's surface and sub-surface process and resulting landforms. (Knowledge Level: Understanding)
- CO3.** Analysis of different landforms and role of active crustal weathering agents to unfold the physiochemical processes of the earth's surface. (Cognitive Level: Analysing)
- CO4.** Exercise on the modern tools and techniques for structural analysis of surface landforms and their relationship with the surrounding. (Cognitive Level: Evaluating and Creating)
- CO5.** Importance of different landforms in the sustainable development of society and the nation. (Cognitive Level: Applying)

GC12: STRUCTURAL GEOLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The students acquaint the knowledge about the topographic, geological maps and its applications. This paper will have major emphasis to genesis and mechanism of primary and secondary geological structures their deformation mechanism and pattern. The structural geology will make students familiar with the geometry and elements of structures ranging from micro-meso scale and its interpretation in small scale and in the field.

Syllabus

Unit	Course Content
I	Introduction to Structural Geology: Primary and Secondary structures, structures and topography, Salt tectonics, Stress and strain in rocks, Progressive deformation.
II	Fabric and tectonites: Foliation and its types, Relationship of foliation with other structures. Cleavage, microscopic properties of cleavage and schistosity, relationship of cleavage with other structures. Lineation, Nature of foliation and lineation and its relationship with major structures
III	Ductile structures: Fold elements and terminology, Classification: geometrical, morphological and genetic, Origin and development of folds, Mechanics of folding, Superposed Folds. Shear zone, nature and types of shear zone, shear sense indicators.
IV	Brittle structures: Classification and origin of joints, veins, relation to other structures. Faults, terminology and classification, structures associated with faults. Fault systems. Mechanics of faulting, thrusts and nappe structures, dome and basin structures, mylonite zone and pseudotachylytes.

Texts / Reference Books

1. Condie K. C. (1982): Plate Tectonics and Crystal Evolution. Pergamon Press Inc., New York, 310p.
2. Davis G.H. and Reynolds S.J. and Kluth C.F. (2011): Structural Geology of Rocks and Regions (3rd Edition). John Wiley and Sons. Inc., 864p. ISBN: 978-0471152316.

3. Fossen H. (2016): Structural Geology (2nd ed). Cambridge University Press, 510p. ISBN-13: 978-1107057647.
4. Ghosh S.K. (2013): Structural Geology, Fundamentals and Modern Developments. Elsevier, 376p. ISBN: 978-0080983998.
5. Hatcher R.D. (1994): Structural Geology, Principles, Concepts and Problems (2nd Edition). Pearson Publisher, 525p. ISBN: 978-0023557132.
6. Lisle R.J. (2021): Geological Structures and Maps: A Practical Guide (4th Edition). Butterworth-Heinemann, 124p. ISBN: 978-0-12-818025-9.
7. Marshak S. and Mitra G. (1988): Basic Methods of Structural Geology. Pearson, 464p. ISBN: 978-0130651785.
8. Park R.G. (2004): Foundation of Structural Geology (3rd Edition). Routledge, 214p. ISBN: 9780748758029.
9. Ragan D.M. (2009): Structural Geology: An Introduction to Geometrical Techniques (4th Edition). Cambridge University Press, 632p. ISBN: 978-0521745833.
10. Twiss, R.J. and Moores, E.M. (2007) Structural Geology (2nd ed). Cambridge University Press, New York, 532 p. ISBN 978-0716749516.

Learning Outcomes

- CO1.** Fundamentals of earth's interior and exterior structures with the stress and strain perspective. (Knowledge Level: Remembering & Understanding)
- CO2.** Decoding the existing structures and stress phenomena on different scales. (Cognitive Level: Understanding)
- CO3.** Conventional and advanced tools and techniques to analyse and interpret common geological structures. (Cognitive Level: Analysing and Evaluating)
- CO4.** Significance of different geological structures in risk and hazard as a prerequisite for the development of a project. (Cognitive Level: Evaluating and Solving Problems)
- CO5.** Field evidence for the structural deformation and its representation in the compilation of a scientific report. (Cognitive Level: Applying and Creating)

GC13: INTRODUCTION TO GEOPHYSICS

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The students will be able to recognize the physical characteristics of geological phenomena of the earth crust with the help of simple geophysical techniques. The paper will enable the students to get the subsurface information derived by scientific subsurface models.

Syllabus

Unit	Course Content
I	Introduction: Role of geophysical data in geological studies. Elastic theory: Stress, Strain, Young's modulus, Rigidity modulus, Bulk modulus, Compressibility, Poisson's ratio; Seismic body and Surface waves; Earthquake seismology: Elastic rebound model, seismograph, Location of the epicenter of an earthquake, Global Seismicity, Earthquake intensity and magnitude, Frequency and energy released, Earthquake prediction.

II	Fundamentals of Gravity method and Magnetic methods: magnetic force, magnetic field strength, magnetic dipole, magnetic susceptibility, Remnant magnetization, magnetic induction, Magnetic properties of rocks, and its application
III	Electrical Resistivity Method: Basic principles of resistivity, Electrical Potential field and resistivity for electrode at depth and surface of the Earth. VES and Profiling methods.
IV	Principle of Seismic Refraction method and Seismic Reflection method: Fundamental of Seismic waves and its type. Attenuation and energy loss, factors affecting seismic velocity, Refraction and reflection of waves. ray-path geometry in layered ground, seismic energy sources.

Texts / Reference Books

1. Dobrin M.B. and Savit C.H. (1988): An introduction to Geophysical Prospecting (4th Edition McGraw-Hill Education, 867p. ISBN: 978-0070171961.
2. Lowrie W. (2007): Fundamentals of geophysics. Cambridge University Press. 391p. ISBN: 9780511352737.
3. Parasnis D.S. (1973): Mining Geophysics (2nd Edition). Elsevier, 414p. ISBN: 9780444601858.
4. Patra H.P. and Mallick K. (1980): Geosounding Principles Vol. II Timarying Geoelectric Soundings. Amsterdam, Elsevier.
5. Reynolds J.M. (1998): An introduction to Applied and Environmental Geophysics. John Wiley and Sons, England, 796p. ISBN: 0-471-96802.
6. Telford W.M., Geldart, L.P. and Sheriff R.E. (1990): Applied geophysics (2nd Edition). Cambridge university press, 770p. ISBN: 9781139167932.

Learning Outcomes

- CO1.** Understanding of basic physical properties of the earth with established geophysical methods. (Knowledge Level: Remembering & Understanding)
- CO2.** Analyse the relationship between gravity potential and the shape of the earth. (Cognitive Level: Analysing)
- CO3.** Interpretation of the gravity, magnetic, electric and seismic properties of earth and rocks for resource estimation. (Cognitive Level: Evaluating and Applying)
- CO4.** Significance of different geophysical methods for the exploration of natural resources for mankind and national development. (Cognitive Level: Applying)
- CO5.** Perform lab analysis for compilation of gravity data for interpretation to achieve natural resources and for civil development projects. (Cognitive Level: Applying and Creating)
- CO6.** Teamwork for performing and handling elements of geophysical data. (Cognitive Level: Problem Solving)

GP11: STRUCTURAL GEOLOGY PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

This practical course introduces students to topographic and geological maps and their applications. It emphasizes the genesis and deformation of primary and secondary geological structures, familiarizing students with their geometry and interpretation from micro- to meso-scale, both in maps and in the field.

Practical/Field Exercise

Course Content
• Surface topographic representation techniques and visualization of features in maps. • Problems of dip, strike and thickness of bed, true dip and apparent dip, pitch, plunge, lines and intersecting planes. • Contour maps and interpretation of geological structures from maps, geological history, completion of outcrops: three-point problem • Exercises on various structural geological problems by graphical and stereographic projection, structural analysis • Field surveys techniques and processes.

Learning Outcomes

- CO1.** Develop skills to read, prepare, and interpret topographic and geological maps. (Knowledge Level: Understanding & Applying)
- CO2.** Identify, measure, and analyse primary and secondary geological structures using field and laboratory methods. (Cognitive Level: Applying & Analysing)
- CO3.** Demonstrate the use of conventional tools (compass clinometer, stereonet, etc.) for structural analysis. (Cognitive Level: Applying)
- CO4.** Interpret micro- to meso-scale structural data and represent them graphically and cartographically. (Cognitive Level: Analysing & Creating)
- CO5.** Compile structural field data into scientific reports with emphasis on deformation patterns and their implications. (Cognitive Level: Evaluating & Creating)
- CO6.** Work collaboratively in the field and lab to conduct structural surveys and present outcomes effectively. (Cognitive Level: Problem Solving & Teamwork)

GP12: GEOLOGICAL FIELD WORK-I

Credits	Out of Classroom Activities	Marks
01 Credit	30 Hours	25 Marks

Course Objectives

The objective of the Geological Field Work course is to provide first-year students with practical training in observing, recording, and interpreting geological features in the field. It enables them to apply classroom concepts to the real-world experiences.

Practical/Field Exercise

Course Content
• Introduction: Purpose and importance of fieldwork in geology with emphasis on observation, recording, and interpretation of surface features; Basic methods for systematic note-taking, sketching, and field diaries preparation. • Maps: Application of topographic representation techniques for understanding landforms, slopes, drainage patterns, and elevations in the field. Use of contour maps and local field sections to visualize geological structures such as folds, faults, and unconformities. • Structural Elements: Use of a compass clinometer to measure dip, strike, pitch, and plunge in actual outcrops; field observations to classroom problems by interpreting the orientation of planes and lines; Stereographic projection and graphical methods to represent natural outcrops.

- **Field Survey Techniques:** Training in essential survey methods including traversing, pacing, and GPS use for geological mapping; Processes of preparing geological maps, plotting observations, and integrating geophysical insights with surface geology.

Learning Outcomes

- CO1.** Develop skills to read, prepare and interpret topographic and geological maps. (Knowledge Level: Understanding & Applying)
- CO2.** Identify, measure, and analyse primary and secondary geological structures using field and laboratory methods. (Cognitive Level: Applying & Analysing)
- CO3.** Recognize and describe different rock types, minerals, and surface geological features in the field. (Knowledge Level: Remembering & Understanding)
- CO4.** Record systematic field observations, prepare geological field notes, and communicate interpretations through sketches, cross-sections, and field reports. (Skill Level: Applying, Analysing & Creating)
- CO5.** Integrate knowledge of physical geology, structural geology, and geophysics to reconstruct the geological history of a field area. (Cognitive Level: Analysing & Evaluating)

GEOLOGY MAJOR SEMESTER-II

GC21: CRYSTALLOGRAPHY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The course aims to develop a fundamental understanding of crystallography by introducing students to the principles of crystal lattices, internal structures and the geometrical arrangement of crystal faces. It seeks to familiarize students with the symmetry elements governing crystals and provide the basis for recognizing and interpreting crystal forms as the framework for studying rock-forming minerals.

Syllabus

Unit	Course Content
I	Introduction: Fundamentals of a crystal and crystal systems; their faces, forms and laws of crystallography; crystal bonding. Crystal Structure: Crystal structure of the elements; lattices, lattice parameters, unit cell; Conventional and primitive lattices; Space Lattice; 14 Bravais Lattice.
II	Crystal Notations: Symmetry elements of crystals; Derivation of 32 classes of Symmetry; Miller notation, Hermann-Mauguin symbols; study of crystal forms of different crystal systems.
III	Morphology of Minerals: Crystal growth, aggregation, multi-crystals, porphyro-blasts, and poikilo-crystals, various growth effects. Polymorphism, isomorphism, pseudomorphism.
IV	Crystal projections: Types of crystal projections; spherical and stereographic projection and their uses. X-ray crystallography: Introduction to X-ray crystallography, and Bragg's equation.

Texts / Reference Books

1. Dana, E.S. and Ford, W.E. (2002) A textbook of Mineralogy.
2. Deer W.A., Howie R.A. and Zussman J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). Prentice Hall, London, 510p. ISBN: 978-0903056274.
3. Klein C. and Hurlbut C. S. Jr (1993): Manual of Mineralogy (21st Edition). John Wiley New York, 681p. ISBN: 0-471-59955-7.
4. Klein C. and Philpotts A., (2016): Earth Materials: Introduction to Mineralogy and Petrology (2nd Ed), Cambridge University Press, 616p., ISBN-13 : 978-1316608852
5. Perkins, D. (2013) Mineralogy, Prentice Hall
6. Read H.H. (1970) Rutley's Elements of Mineralogy. Thomas Murby & Co., 560p.
7. Rutley's Elements of Mineralogy, by Gribble (2005): CBS Publishers, ISBN-10: 8123909160.

Learning Outcomes

- CO1.** Nomenclature of major crystal systems with different measurement and analytical techniques. Classification of common minerals and their association in different rocks. (Cognitive Level: Understanding)
- CO2.** Learn graphical depiction of a crystal and geochemical representation of common minerals. (Cognitive Level: Analysing and Creating)

- CO3.** Availability and spatiotemporal distribution of common mineral and their role in the development of nation and mankind. (Cognitive Level: Evaluating and Applying)
- CO4.** Perform lab analysis for optical and physical properties of a mineral. Prepare crystal models individually and in a team under the constant supervision of experts. (Cognitive Level: Evaluating and Applying)
- CO5.** Represent the findings of analysis professionally in the form of reports, and oral or visual presentations of data. (Cognitive Level: Analysing and Creating)

GC22: MINERALOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The course aims to provide students with a comprehensive understanding of crystallography and mineralogy by introducing the principles of crystal lattice, symmetry, and the arrangement of crystal faces. It focuses on the physico-chemical properties, origin, formation processes, and occurrence of minerals, with special emphasis on rock-forming minerals. Students will also learn the fundamentals of mineral paragenesis and optical properties, enabling them to analyse and interpret the characteristics and genesis of minerals in geological contexts.

Syllabus

Unit	Course Content
I	Fundamentals of Mineralogy: Introduction to minerals, their classification and various compositional groups (silicates, oxides, phosphates, sulphates and sulphides etc.), Processes of mineral formation; Common physical properties of minerals
II	Mineralogy of major rock-forming minerals; Silicate and non-silicate structures; CCP and HCP structures.
III	Twinning and its important laws; common types of twins and their examples.
IV	Optical Mineralogy: Nature of light and principles of optical mineralogy; introduction to the petrological microscope, Ordinary and polarized lights; Optics of Isotropic and anisotropic minerals, Uniaxial and Biaxial optics, pleochroism, Interference figures, crystal orientation, and identification of common rock-forming minerals under microscope

Texts / Reference Books

- Deer W.A., Howie R.A. and Zussman J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). Prentice Hall, London, 510p. ISBN: 978-0903056274.
- Klein C. (2007): Minerals and Rocks (3rd Edition). John Wiley and Sons New York, 456p. ISBN: 978-0471772774.
- Klein C. and Hurlbut C. S. Jr (1993): Manual of Mineralogy (21st Edition). John Wiley New York, 681p. ISBN: 0-471-59955-7.
- Klein C. and Philpotts A., (2016): Earth Materials: Introduction to Mineralogy and Petrology (2nd Ed), Cambridge University Press, 616p., ISBN-13 : 978-1316608852
- Nesse D.W. (2012): Introduction to Optical Mineralogy (4th Edition). Oxford University Press, 361p. ISBN: 978-0199846276.
- Read H.H. (1970): Rutley's Element of Mineralogy (26th Edition). Springer Netherlands, 560p. ISBN: 978-94-011-9769-4, 9780045490059.

Learning Outcomes

- CO1.** Introduction and understanding of natural minerals and their physiochemical behaviour, their process of crystallisation in specific crystal groups. (Knowledge Level: Remembering & Understanding)
- CO2.** Nomenclature of major crystal systems with different measurement and analytical techniques. Classification of common minerals and their association in different rocks. (Cognitive Level: Understanding)
- CO3.** Learn graphical depiction of a crystal and geochemical representation of common minerals. (Cognitive Level: Analysing and Creating)
- CO4.** Availability and spatiotemporal distribution of common minerals and their role in the development of nation and mankind. (Cognitive Level: Evaluating and Applying)
- CO5.** Environmental impacts and association of common minerals in the lithosphere, hydrosphere and atmosphere. (Cognitive Level: Problem Solving)

GC23: IGNEOUS PETROLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

This course introduces the classification, origin, evolution, and field occurrence of igneous rocks. It explores magmatic processes, tectonic settings, phase equilibria, and geochemical tools used in petrology. Laboratory work emphasizes hand specimen identification, thin section petrography, and geochemical data interpretation.

Syllabus

Unit	Course Content
I	Introduction: Igneous Rocks & Rock Cycle, Classification of Igneous Rocks Magma and magmatic bodies: Magma generation in the crust and upper mantle. Physical properties of magma - temperature, viscosity, density and volatile content.
II	Genesis, properties, emplacement and crystallization of magmas. Bowen's reaction Series and its application, Magmatic differentiation- fractional crystallization, partial melting, assimilation and their role in magmatic differentiation
III	Forms, Texture and Microstructure: Mode of occurrence of igneous rocks. Mechanisms of magmatic intrusions. Forms of igneous rocks. Crystallinity, granularity, shapes and mutual relations of grains; nucleation and growth of minerals in magma; Description of the textures and microstructures with their occurrence in different rocks. Various Igneous structures.
IV	Phase diagrams: Solid solution and exsolution. Steady-state geotherms. Phase equilibrium studies of simple systems (phase rule and one- and two-component Systems, systems with more than two components), effect of volatiles on melt equilibria. Magma -mixing, - mingling and -immiscibility. Phase equilibria of binary and ternary systems. Igneous Rock Suites: Ophiolites & Island Arcs, Continental Igneous Provinces. Phase rule application to H ₂ O system.

Texts / Reference Books

1. Best M.G. (2002): Igneous and Metamorphic Petrology. Blackwell Science Blackwell Science Ltd., 2003; ISBN: 1-40510-588-7; 752p.

2. Klein C. and Philpotts A., (2016): Earth Materials: Introduction to Mineralogy and Petrology (2nd Ed), Cambridge University Press, 616p., ISBN-13 : 978-1316608852
3. Philpotts, A.R. and Ague, J.J. (2018): Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge, United Kingdom. ISBN13 9780521880060.
4. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
5. Winter J.D. (2010): Principles of Igneous and Metamorphic Petrology. Prentice-Hall of India Pvt. Ltd., Prentice Hall, 728p. ISBN: 9788120343979, 9788120343979.

Learning Outcomes

- CO1.** Classify and identify igneous rocks in hand samples and thin sections. (Knowledge Level: Remembering & Understanding)
- CO2.** Understand the origin and evolution of magmas. (Cognitive Level: Understanding)
- CO3.** Interpret phase diagrams related to igneous systems. (Cognitive Level: Analysing and Evaluating)
- CO4.** Use geochemical tools to analyse igneous processes and tectonic settings. (Cognitive Level: Evaluating and Creating)

GP21: CRYSTALLOGRAPHY AND MINERALOGY PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

This practical course introduces students to topographic and geological maps and their applications. It emphasizes the genesis and deformation of primary and secondary geological structures, familiarizing students with their geometry and interpretation from micro- to meso-scale, both in maps and in the field.

Practical/Field Exercise

Course Content
• Identify and describe the physical properties of major rock-forming minerals through hand specimen study. • Operate a polarizing microscope and apply it to determine the optical properties of minerals. • Examine and interpret the optical characteristics of key rock-forming minerals such as olivine, garnet, pyroxene, amphibole, mica, feldspar, and quartz. • Analyze elements of symmetry and classify representative crystals into different crystal systems. • Recognize and demonstrate the major crystal forms and their crystallographic significance. • Perform measurements of crystallographic attributes and develop skills in crystal projection techniques.

Learning Outcomes

- CO1.** Identify and describe the physical and optical properties of major rock-forming minerals using hand specimens and polarizing microscopes. (Knowledge Level: Remembering & Understanding)
- CO2.** Examine and interpret diagnostic optical characteristics of key minerals such as olivine, garnet, pyroxene, amphibole, mica, feldspar, and quartz. (Cognitive Level: Analysing & Evaluating)
- CO3.** Analyse symmetry elements and classify representative crystals into appropriate crystal systems. (Knowledge Level: Understanding & Applying)

- CO4.** Recognize, demonstrate, and explain major crystal forms along with their crystallographic significance. (Cognitive Level: Understanding & Analysing)
- CO5.** Perform measurements of crystallographic attributes and apply crystal projection techniques for accurate representation. (Cognitive Level: Applying & Creating)

GP22: PETROLOGY-I PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

The objective of the Geological Field Work course is to provide first-year students with practical training in observing, recording, and interpreting geological features in the field. It enables them to apply classroom concepts to the real-world experiences.

Practical/Field Exercise

Course Content
• Study of rocks in hand specimens and in thin sections of igneous rocks. • Process for the preparation of rock's thin section. • Study of igneous structures. • Textural analysis of rocks.

Learning Outcomes

- CO1.** Develop skills to read, prepare and interpret topographic and geological maps. (Knowledge Level: Understanding & Applying)
- CO2.** Identify, measure, and analyse primary and secondary geological structures using field and laboratory methods. (Cognitive Level: Applying & Analysing)
- CO3.** Recognize and describe different rock types, minerals, and surface geological features in the field. (Knowledge Level: Remembering & Understanding)
- CO4.** Record systematic field observations, prepare geological field notes, and communicate interpretations through sketches, cross-sections, and field reports. (Skill Level: Applying, Analysing & Creating)
- CO5.** Integrate knowledge of physical geology, structural geology, and geophysics to reconstruct the geological history of a field area. (Cognitive Level: Analysing & Evaluating)

GEOLOGY MAJOR (SEMESTER-III)

GC31: SEDIMENTOLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

This course provides a comprehensive overview of sedimentary geology, focusing on the origin, classification, and evolution of sedimentary rocks and processes. Students will explore surface processes, weathering, sediment transport dynamics, and depositional environments. Emphasis will be placed on sedimentary textures, structures, diagenesis, and facies analysis. The course also covers the tectonic controls on sedimentation and the formation of sedimentary basins, integrating geosynclinal and plate tectonic models to reconstruct paleoenvironments and basin evolution.

Syllabus

Unit	Course Content
I	Surface processes and weathering of rocks, Sedimentary textures. Classification of sedimentary rocks: conglomerates, sandstones, shales, and carbonate rocks, Ironstones, Chert and Evaporites.
II	Provenance of clastic sediments, Diagenesis of siliciclastic and carbonate rocks.
III	Elements of hydraulics. Processes of sediment transport, Important Sedimentary structures.
IV	Introduction to sedimentary facies and depositional environments. Introduction to sedimentary basins.

Texts / Reference Books

1. Lindholm R.C. (1987): A Practical Approach to Sedimentology. Allen and Unwin, London, 276p.
2. Miall A.D. (2000): Principles of Sedimentary Basin Analysis. Springer-Verlag, 628p. ISBN-10: 3540657908
3. Prothero D.R. and Schwab F. (2004): Sedimentary Geology. Freeman, 600p. ISBN-10-716739054.
4. Reading H.G. (1997): Sedimentary Environments and facies. Blackwell Scientific Publication, ISBN 0-632-03627-3.
5. Sengupta S.M. (2007): Introduction to sedimentology. CBS Publ, New Delhi, 339p., ISBN 81-239-1491-1,

Learning Outcomes

- CO1.** Explain the mechanisms of rock weathering, soil formation, and the genesis of paleosols. (Knowledge Level: Remembering & Understanding)
- CO2.** Distinguish between clastic, chemical, biogenic, and volcanogenic sediments based on origin and composition. (Cognitive Level: Understanding and Analysing)
- CO3.** Analyse sedimentary textures and interpret depositional environments based on rock characteristics and provenance. (Cognitive Level: Analysing and Evaluating)
- CO4.** Interpret sedimentary structures, bedforms, and flow regimes using basic hydraulic principles and sediment transport processes. (Cognitive Level: Evaluating and Applying)

- CO5.** Understand the relationship between tectonics and sedimentation, and apply basin analysis methods to interpret the formation and evolution of sedimentary basins. (Cognitive Level: Creating and Problem Solving)

GC32: METAMORPHIC PETROLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The paper, mainly dealing with Metamorphic Processes and Products, introduces students to the rocks that have been affected by the P-T-fluid phase during and after their formation by natural processes. The tell-tale signatures in rocks and minerals are picked carefully to reconstruct their spatial and temporal evolution in varied Earth surface and subsurface regimes.

Syllabus

Unit	Course Content
I	Introduction to Metamorphism: Definition and Scope, Understanding metamorphism and its significance in the rock cycle. Agents of Metamorphism, Role of temperature, pressure, and chemically active fluids. Types of Metamorphism, Contact, regional, dynamic, burial, hydrothermal, and impact metamorphism
II	Metamorphic Textures and Structures: Textures, Grain size variations, foliation, lineation, and porphyroblastic textures, Structures: Schistosity, gneissic banding, and other structural features indicative of metamorphic processes.
III	Metamorphic Mineral Assemblages and Facies: Mineral Assemblages, Identification and significance of index minerals, Metamorphic Facies: Concept, classification, and their relation to pressure-temperature conditions, Facies Series: Understanding Barrovian and Buchan series. Combinatorial formula and Schreinemakers rules and Mineral formula calculation. Metamorphic Zones and Isograds: Metamorphic Zones: Concept of metamorphic zones and their significance, Isograds: Definition and role in mapping metamorphic grade transitions. Progressive regional metamorphism of pelitic bulk compositions, metamorphic path in evolution of mineral assemblages.
IV	Metamorphic Reactions and Thermodynamics: Metamorphic Reactions, Dehydration, decarbonation, and exchange reactions, Thermodynamic Principles: Gibbs free energy, phase equilibria, and the phase rule, Chemographic Diagrams: Use of ACF, AKF, and AFM diagrams in interpreting metamorphic processes. Tie-line flip and rotations, continuous and discontinuous reactions, thermodynamic principles of metamorphic reactions, exchange vectors, Clausius-Clayperon equation. Plate Tectonics and Metamorphism: Tectonic Settings: Relationship between metamorphism and plate boundaries, Paired Metamorphic Belts.

Texts / Reference Books

1. Best M.G. (2002): Igneous and Metamorphic Petrology. Blackwell Science Blackwell Science Ltd., 2003; ISBN: 1-40510-588-7; 752p.
2. Bucher, K. and Grapes, R. (2010): Petrogenesis of Metamorphic Rocks, Springer.
3. Philpotts A., & Ague J. (2022): Principles of Igneous and Metamorphic Petrology (3rd ed.). Cambridge University Press. ISBN 978-1-108-49288. doi:10.1017/9781108631419.

4. Spear F.S. (1995) Metamorphic Phase Equilibria and Pressure-Temperature-Time-Paths. Mineralogical Society of America Monograph. ISBN: 0-939950-34-0. 799; p.
5. Vernon R.H., Clarke G.L. (2008): Principles of Metamorphic Petrology. Cambridge University Press, ISBN: 978-0-521-87178-5; 366p.
6. Winter J.D. (2014): Principles of Igneous and Metamorphic Petrology (2nd edition), Pearson Education Limited, ISBN 13: 978-1-292-02153-9; 745p.
7. Yardley B. and Warren C. (2021): An Introduction to Metamorphic Petrology (2nd). Cambridge University Press, ISBN-13: 978-1108471558; 334p.

Learning Outcomes

- CO1.** Major theories to understand the metamorphism and related rock-forming processes. (Knowledge Level: Remembering & Understanding)
- CO2.** Analysis of major metamorphic facies and grades required for the formation of metamorphic rock. (Cognitive Level: Analysing and Evaluating)
- CO3.** Process and significance of triangular plots to explain the composition and physicochemical environment of a metamorphic rock or terrain. (Cognitive Level: Applying and Creating)
- CO4.** Modern tools and techniques to interpret and representation of metamorphic facies of a terrain. (Cognitive Level: Applying and Creating)
- CO5.** Role of metamorphic mineral deposits in the sustainable development of nation and society. (Cognitive Level: Problem Solving)

GC33: GEO-TECTONICS

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The paper discusses the basic phenomenon of continuous and discontinuous deformation due to the dynamic instability of the crust. The paper also unravels the underlying deformation processes and mechanisms through an accurate geometric and kinematic analysis of complex natural structures.

Syllabus

Unit	Course Content
I	Introduction to Geotectonics: Definition and scope of geotectonics, Historical development of tectonic theories, Earth's internal structure, Concept of isostasy and types (Airy, Pratt's model) Continental Drift and Sea-Floor Spreading: Wegener's theory of continental drift and supporting evidence, Sea-floor spreading hypothesis (Hess's theory), Magnetic anomalies and paleomagnetism, Ocean floor features: mid-ocean ridges, trenches, seamounts
II	Plate Tectonics Theory: Plate boundaries: divergent, convergent, transform, Plate interactions and driving mechanisms, Hotspots and mantle plumes, Triple junctions and plate configurations, Types of orogeny: collision, subduction-related, accretionary, Case studies: Himalayas, Andes, Alps, Evolution of mountain chains and structural trends, Fold and thrust belts
III	Tectonics and Earthquakes: Fault types and earthquake generation, Seismic waves and tectonic settings of earthquakes, Seismotectonics and earthquake zones of the world, Elastic rebound theory and plate boundary seismicity.

	Tectonics and Basin Formation: Classification of sedimentary basins: rift, foreland, intermontane, Tectonic control on sedimentation, Basin subsidence mechanisms, Examples of major global sedimentary basins
IV	Geodynamics and Recent Developments: Mantle convection and lithospheric dynamics, Plate reconstructions and supercontinent cycles (Rodinia, Pangaea), GPS and geodetic measurements in tectonic studies, Neotectonics and active tectonics, Geodynamic Evolution of Himalaya

Texts / Reference Books

1. Burbank D.W. and Anderson R.S. (2011): Tectonic Geomorphology (2nd Edition). Wiley-Blackwell, 460p. ISBN: 978-1-444-33887-4
2. Condie, Kent. C. (1989): Plate Tectonics and Crustal Evolution (3rd Edition). Butterworth-Heinemann Ltd., 375p. ISBN: 978-0080348735.
3. Davies G.F. (1999): Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press, 472p. ISBN: 978-0521599337.
4. Kearey P., Klepeis K.A. and Vine F.J. (2009): Global Tectonics (3rd Edition). Wiley-Blackwell, 496p. ISBN: 978-1-405-10777-8.
5. Keller E.A and Pinter N. (2001): Active Tectonics: Earthquakes, Uplift, and Landscape (2nd Edition). Pearson Publications, 384p. ISBN: 978-0130882301.
6. Moores, E.M., & Twiss, R.J. – Tectonics
7. Windley B. (1995): The Evolving Continents (3rd Edition). Wiley-Blackwell, 544p. ISBN: 978-0471917397.

Learning Outcomes

- CO1.** Concept of lithospheric plates and hypothesis of unstable earth's surface and related landforms. Driving Forces of Plate Tectonics: Mantle convection, slab pull, ridge push, and their implications. (Knowledge Level: Remembering & Understanding)
- CO2.** The geodesic concept for crustal stress phenomenon and mechanisms of crustal growth and transfer of heat at spreading ocean ridges. (Cognitive Level: Understanding)
- CO3.** Critical evaluation of theories and evidence of tectonics to understand the motion of the lithospheric plates over geological time. (Cognitive Level: Evaluating)
- CO4.** Measurement techniques for plate motion and role of plate boundaries in stress localisation and risk management. (Cognitive Level: Analysing and Applying)
- CO5.** Implications of neotectonics in the development of a society with the development of different landforms. (Cognitive Level: Creating and Problem Solving)

GP31: PETROLOGY-II PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

This practical course introduces students to the study of sedimentary and metamorphic rocks through hand specimens and thin sections, along with essential laboratory techniques such as grain size analysis. It emphasizes the identification and interpretation of sedimentary structures, facies, mineral chemistry, and metamorphic features, enabling students to understand depositional environments and metamorphic processes. The course further develops skills in petrographic analysis and interpretation of structures for reconstructing geological histories.

Practical/Field Exercise

Course Content
• Study of rocks in hand specimens and in thin sections • Study of sedimentary structures and Paleo-current analysis • Clastic grain-size analysis. Roundness and shape analyses of clastic grains • Identification of metamorphic rocks in hand specimens • Thin Section Petrography • Mineral Chemistry and Pleochroism • Metamorphic Facies Interpretation • Reaction Texture Identification • Identification of secondary structures and its interpretation

Learning Outcomes

- CO1.** Identify and describe sedimentary, clastic, carbonate, and metamorphic rocks in hand specimens and thin sections using standard petrographic techniques. (Cognitive Level: Understanding & Applying)
- CO2.** Perform grain size analysis, heavy mineral separation, and petrographic examination to determine the composition and texture of sedimentary and metamorphic rocks. (Cognitive Level: Applying & Analysing)
- CO3.** Interpret sedimentary structures, facies characteristics, and depositional environments based on hand specimen studies and microscopic observations. (Cognitive Level: Analysing)
- CO4.** Analyze mineral chemistry, pleochroism, and reaction textures in thin sections to understand mineralogical variations and metamorphic processes. (Cognitive Level: Analysing & Evaluating)
- CO5.** Integrate petrographic data, facies analysis, and structural observations to interpret geological history and prepare scientific reports. (Cognitive Level: Evaluating & Creating)

GP32: GEOLOGICAL FIELD WORK-II

Credits	Out of Classroom Activities	Marks
01 Credit	30 Hours	25 Marks

Course Objectives

The objective of this Geological Field Work course is to provide students with practical training in observing, identifying, and interpreting sedimentary and metamorphic rocks, structures, and facies in the field. It enables them to apply laboratory and classroom knowledge, such as grain characteristics, sedimentary structures, facies relationships, and metamorphic features, to real geological settings. The course also develops skills in systematic field recording, sampling, and preliminary interpretation for reconstructing depositional environments and metamorphic histories.

Practical/Field Exercise

Course Content

- **Introduction:** Purpose and significance of geological fieldwork with emphasis on observation, documentation, and interpretation of sedimentary and metamorphic features; methods of maintaining field notes, sketching outcrops, and preparing systematic field diaries.
- **Lithological Identification:** Field identification of sedimentary and metamorphic rocks in hand specimens; recognition of textural variations, grain size, mineral composition, and field characteristics of clastic, carbonate, and metamorphic rocks.
- **Sedimentary Structures & Facies:** Identification and interpretation of primary sedimentary structures such as bedding, cross-bedding, ripple marks, graded bedding, and biogenic features; understanding lateral and vertical facies variations and their significance in reconstructing depositional environments.
- **Metamorphic Features:** Field recognition of metamorphic structures including foliation, lineation, schistosity, gneissic banding, and identification of metamorphic facies and index minerals; interpretation of reaction textures and metamorphic evolution.
- **Sampling & Laboratory Linkages:** Techniques for systematic sample collection for grain size analysis, petrography, and heavy mineral studies; correlation of field observations with laboratory analyses such as thin section petrography, mineral chemistry, and micro-textural interpretation.

Learning Outcomes

- CO1.** Develop skills to observe, record, and interpret sedimentary and metamorphic features in the field. (Knowledge Level: Understanding & Applying)
- CO2.** Identify and describe sedimentary and metamorphic rocks, structures, and facies in natural outcrops. (Cognitive Level: Remembering & Understanding)
- CO3.** Analyse sedimentary structures, facies variations, and metamorphic features to interpret depositional environments and metamorphic conditions. (Cognitive Level: Applying & Analysing)
- CO4.** Record systematic field observations, prepare field notes, sketches, and logs, and communicate interpretations through field reports. (Skill Level: Applying, Analysing & Creating)
- CO5.** Integrate field observations with laboratory studies (petrography, grain size, and mineral analysis) to reconstruct geological history. (Cognitive Level: Analysing & Evaluating))

GEOLOGY MAJOR SEMESTER-IV

GC41: STRATIGRAPHY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

The stratigraphy is fundamental to understand the Earth's history by a systematic arrangement of rock succession through time and space which form the principal archive of past events, climates and environments through time. The students will learn in this paper about the principles of stratigraphy and details of major Geological records of India.

Syllabus

Unit	Course Content
I	Introduction: Basic principles and definitions; Stratigraphic classification and Nomenclature; Brief account on Magnetostratigraphy; Stratigraphic correlation, Paleontologic and non-paleontologic criteria of correlation; Graphic correlation.
II	Precambrian Stratigraphy: Dharwar, Singhbhum, Bastar, Aravalli and Bundelkhand Cratons
III	Proterozoic sedimentary basins of India, Mobile Belts of India. Phanerozoic Stratigraphy: Paleozoic Era: Paleogeographic, paleoclimatic and tectonic set up. A detailed study of succession, lithology, age, depositional environments, economic importance and fossil contents of various formations of Salt Range, Tethys Himalaya and Lesser Himalaya Ranges; Gondwana sequences. Mesozoic Era: Paleogeographic, paleoclimatic and tectonic set up. A detailed study of succession, lithology, age, depositional environments, economic importance and fossil contents of various formations of Extra-peninsular and Peninsular India.
IV	Cenozoic Era: Paleogeographic, paleoclimatic and tectonic set up along with Himalayan Orogeny. A detailed study of succession, lithology, age, depositional environments, economic importance and fossil contents of various Paleogene and Neogene formations of Extra-peninsular and Peninsular India; Siwalik Supergroup. Deccan Traps: distribution, petrology and age. Lameta beds, Bagh beds, Intertrappeans and Infratrappeans.

Texts / Reference Books

1. Krishnan M.S. (2012): Geology of India and Burma (6th Edition). CBS Publishers and Distributors, 536p. ISBN: 8123900120, 978-8123900124.
2. Kumar R. (2018): Fundamental of Historical Geology and Stratigraphy of India. New Age Intl. Publishers, New Delhi, 268p. ISBN: 0852267452, 978-0852267455.
3. Nichols G. (2009): Sedimentology and Stratigraphy (2nd Edition). Blackwell Science, Oxford, 433p. ISBN: 978-1-4051-9379-5.
4. Ramakrishnan M., and Vaidyanadhan R. (2008): Geology of India (Volume-1), Geological Soc. of India, Bangalore, 556p. ISBN: 978-81-85867-98-4.
5. Ramakrishnan M., and Vaidyanadhan R. (2008): Geology of India (Volume-2), Geological Soc. of India, Bangalore, 428p. ISBN: 978-81-85867-98-4.

Learning Outcomes

- CO1.** Common principles and hypotheses for rock stratification and stratigraphic correlation between various lithological units and geologic time with the stratigraphic record. (Knowledge Level: Remembering & Understanding)
- CO2.** Analysis of geological history with the nomenclature of major stratigraphic units. (Cognitive Level: Analysing)
- CO3.** Significance of the evolution of various cratons with time and mobile belts of India. (Cognitive Level: Evaluating)
- CO4.** Rationales for the development of mountain belts and related stratigraphic records. (Cognitive Level: Applying)
- CO5.** Drafting techniques to represent the paleontological records for stratigraphic division and correlation of Phanerozoic fossiliferous sequences. (Cognitive Level: Creating and Problem Solving))

GC42: PALEONTOLOGY

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

Paleontology is the scientific study of life of the geologic past that involves the analysis of plant and animal fossils, including those of microscopic size, preserved in rocks. It is concerned with all aspects of the biology of ancient life forms: their shape and structure, evolutionary patterns, taxonomic relationships with each other and interrelationships with the environment.

Syllabus

Unit	Course Content
I	Introduction: Definition, subdivision and scopes of Paleontology. Fossils: Definition, character, kinds (body and trace) and applications. Conditions and modes of fossilization. Classification and nomenclature. Concept of species. Paleoecology; concepts and approaches. Taphonomy.
II	Megafossils: Study of morphological characters and geological distribution of the following invertebrate groups: Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, Echinoidea, Trilobita and Graptoloidea. Heteromorphs and extinction in ammonites. Evolutionary trends in Ammonoidea and Graptoloidea. Functional morphology of Bivalvia.
III	Introduction to paleobotany with special reference to Gondwana plant fossils. Introduction to vertebrate paleontology. Vertebrate life through geological time. Study of Siwalik vertebrate fauna. Brief study about dinosaur, horse and primate.
IV	Microfossils: Elements of micropaleontology and its practical applications. Collection and preparation of microfossils. Types of microfossils. Brief morphological study of the following microfossil groups and their paleoclimatic/paleoceanographic and biostratigraphic significance; Calcareous (Foraminifera and Ostracoda), Siliceous (Radiolaria) and Phosphatic (Conodonts).

Texts / Reference Books

1. Raup D.M. and Stanley S.M. (1985): Principles of Palaeontology (CBS Publications), W.H.Freeman and Company, New York , 481 pages.

2. Benton M.J. (1990): Vertebrate Paleontology. Unwin Hyman, London, 452p. ISBN: 0-632-05614-2.
3. Shrock R.R. and Twenhofel W.H. (1999): Principles of Invertebrate Paleontology, CBS Publ., N. Delhi. Textbook Publishers, 816p. ISBN: 075818395X, 9780758183958.
4. Wood H. (1997): Paleontology Invertebrate (9th Edition), CBS Publ., N. Delhi.
5. Saraswati P.K. and Srinivasan M.S. (2016): Micropaleontology: Principles and Applications, Springer.
6. Moore R.C., Lalicker C. G. and Fischer A.G. (1997): Invertebrate Fossils, CBS Publ., N. Delhi. CBS Publishers and Distributors Private Ltd., 2004; ISBN: 8123911394, 766p.
7. Haq B.U. and Boersma A. (1998): Introduction to Marine Micropaleontology, Elsevier, 376 pages, ISBN: 0444826726
8. Clarkson E.N.K. (1998): Invertebrate Palaeontology and Evolution, ELBS/Allen and Unwin, London, 382p. ISBN: 0-04-560010-4.
9. Prothero D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Edition), McGraw Hill.

Learning Outcomes

- CO1.** Basic knowledge about the nature of past life and understanding of the scope of the study of the fossil record. (Knowledge Level: Remembering & Understanding)
- CO2.** Develop skills to search and collect the fossils in the field and their preparation in the lab to make them presentable and suitable for further study. (Cognitive Level: Analysing)
- CO3.** Understand the handling of basic and advanced instruments/devices to apply with the paleontologic/micropaleontological data. (Cognitive Level: Understanding and Applying)
- CO4.** Visual analysis for the paleoecologic, paleoenvironmental and paleobiogeographic set-up of the region and to understand the relationship between biotic and climatic events of the past through time. (Cognitive Level: Evaluating and Applying)
- CO5.** Experience the changing nature of the organic world through geologic time with the detailed study of the fossil record in the lab and field. (Cognitive Level: Applying and Creating)
- CO6.** Understand the high-resolution changes in climatically induced past ocean systems by applying marked changes in microfossil records through time. (Cognitive Level: Understanding and Applying)
- CO7.** Significance of paleoenvironmental record in the identification of natural resources. (Cognitive Level: Problem Solving)

GC43: COMPUTER PROGRAMMING IN GEOSCIENCES

Credits	Lecture /Tutorial	Marks	
		External Exam	Internal Exam
02 Credits	02 Hours/Week	35 Marks	15 Marks

Course Objectives

This course introduces students to basic computer operations, including the use of MS Word, Excel, PowerPoint, and elementary graphics software. It covers fundamental computer architecture, number systems, and data representation, along with concepts of flowcharts and algorithms. Students will gain practical experience in C++ programming—covering input/output, variables, conditions, loops, functions, file handling, and preprocessor directives. The course also includes an introduction to elementary statistics and commonly used utility software.

Syllabus

Unit	Course Content
I	Fundamentals of Computer: Introduction to computer systems; number system, integer, signed integer, fixed and floating-point representations; IEEE standards integer and floating-point arithmetic; CPU organization, ALU, registers, memory, the idea of program execution at micro level; concept of flow chart and algorithms, algorithms to programs.
II	Elementary idea of computer: use of word, MS Excel, Power Point, Basic knowledge of graphics and drawing software.
III	Basic Programming: Basic programming and Aspects of C++: Input/Output: Constants, variables, expressions and operations; Naming conventions and styles; Conditions and selection statements; Looping and control structures; File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking.
IV	Introduction to Machine Learning with Python: Basics of programming in Python, Problem solving using Python programming, Classification of Machine Learning; Supervised, unsupervised and reinforcement learning; Algorithms.

Texts / Reference Books

1. Buttkus B. (2000). Python for geosciences. Springer. ISBN: 9783540662695.
2. de Smith M.J., Goodchild M.F. and Longley P.A. (2023). Geospatial analysis: A comprehensive guide to principles, techniques and software tools (7th ed.). ISBN (Print): 9781905839934.
3. Pimpler E. (2015). Programming ArcGIS with Python Cookbook (2nd ed.). Packt Publishing. ISBN: 9781785282898.
4. Robert L. (1999) Object Oriented Programming C++, Galgotia Publication, ISBN: 8185623228.
5. Sarma D.D. (2009) Geostatistics With Applications in Earth Sciences (2nd Ed), Springer Nature, 205p, ISBN-13: 978-1402093791

Learning Outcomes

- CO1.** Demonstrate Basic Computer and Software Proficiency. (Knowledge Level: Understanding)
- CO2.** Understand Computer Fundamentals and Architecture. (Cognitive Level: Understanding)
- CO3.** Develop and Implement Basic Algorithms in programming. (Cognitive Level: Analysing and Creating, Problem Solving)
- CO4.** Apply Elementary Statistical Tools and Utility Software. (Cognitive Level: Applying and Problem Solving)

GP41: COMPUTER PROGRAMMING IN GEOSCIENCES PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

This practical course introduces students to essential computer applications and programming skills using MS Word, MS Excel, PowerPoint, and C++. It emphasizes the creation and management of documents, data analysis, and effective presentation techniques. The course further develops problem-solving abilities through basic programming concepts, including loops, conditions, and file handling. It enables students to integrate computational tools for academic and practical applications.

Practical/Field Exercise

Course Content
• MS Word: Create and format text documents, add images, and design simple forms. • MS Excel: Perform calculations, create graphs, and analyze data. • PowerPoint: Design slideshows, add animations, and present ideas. • C++ Programming: Write small programs, use loops and conditions, handle file I/O, and debug basic syntax issues.

Learning Outcomes

- CO1.** Develop skills in creating, formatting, and managing documents using MS Word, including insertion of images and basic form design. (Knowledge Level: Understanding & Applying)
- CO2.** Apply MS Excel tools to perform calculations, organize data, generate graphs, and carry out basic data analysis. (Cognitive Level: Applying & Analysing)
- CO3.** Design and deliver effective presentations using PowerPoint with appropriate use of layouts, animations, and visual elements. (Skill Level: Applying & Creating)
- CO4.** Write, compile, and debug basic programs in C++ using fundamental programming concepts such as loops, conditions, and file handling. (Cognitive Level: Applying & Analysing)
- CO5.** Integrate knowledge of office tools and programming skills for efficient problem-solving, data handling, and presentation of results. (Cognitive Level: Analysing & Evaluating)

GP42: PALEONTOLOGY PRACTICAL

Credits	Practical	Marks
01 Credit	02 Hours/Week	25 Marks

Course Objectives

This practical course introduces students to the study of fossils through hand specimens and microscopic techniques. It emphasizes the identification and interpretation of morphological and functional features of invertebrate fossils, bivalves, and Gondwana plant fossils. The course also develops skills in the preparation, picking, mounting, and microscopic analysis of microfossils, including planktic and benthic foraminifera, enabling students to understand their paleoenvironmental significance.

Practical/Field Exercise

Course Content
• Study of specimens illustrating various modes of occurrence of fossils. • Study of morphological characters of some important Invertebrate fossil genera. • Study of functional morphology of bivalvia shells. • Study of morphological characters of some important Gondwana plant fossils. • Preparation, picking and mounting of microfossils. • Microscopic study of various types of microfossils. • Microscopic study and sketching of important planktic and benthic foraminiferal genera.

Learning Outcomes

- CO1.** Understand the modes of occurrence and preservation of fossils through the study of hand specimens. (Knowledge Level: Understanding)

- C02.** Identify and describe morphological characters of important invertebrate fossil genera and Gondwana plant fossils. (Cognitive Level: Remembering & Understanding)
- C03.** Analyse the functional morphology of bivalve shells in relation to their mode of life and environment. (Cognitive Level: Analysing & Applying)
- C04.** Develop practical skills in the preparation, picking, mounting, and microscopic examination of microfossils. (Skill Level: Applying & Analysing)
- C05.** Interpret and illustrate microscopic features of planktic and benthic foraminifera through observation and scientific sketching. (Skill Level: Analysing & Creating)

GEOLOGY MINOR SEMESTER-I

GM11: GENERAL GEOLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This paper provides a foundational introduction to Earth Sciences and its essential attributes. It familiarizes students with popular hypotheses regarding the origin and evolution of the Earth and the solar system. The course further explores surface and sub-surface processes driven by various earth-shaping agents such as weathering, erosion, volcanism, and tectonics. Emphasis is placed on understanding major rock-forming processes and their role in shaping the Earth's crust, with a particular focus on the relationship between these processes and the present distribution of continents.

Syllabus

Course Content
Geology and its branches; concept of isostasy and continental drift theory; Earth and solar system; Space and time scales of processes in the solid Earth, atmosphere and oceans. Composition of the earth; interior of the earth; age of the earth; elements of geological timescale and rock record. Concept of erosion cycles; Weathering, Exhumation and soil formation; natural water and rock cycle. Erosional landforms.

Texts / Reference Books

1. Holmes, Arthur (2016): Principles of Physical Geology (3rd Edition). Thomas Nelson and Sons Ltd., London (also available in paperback of 1978 edition), 628p. *ISBN: 978-0471072515*.
2. Ritter D.F., Kochel R.C. and Miller J.R. (2006): Processes of Geomorphology (4th Edition). Waveland Press, 560p. *ISBN: 978-1577664611*.
3. Singh Savindra (1998): Geomorphology (3rd Edition). Prayag Pustak Bhawan, 613p. *ISBN: 8186539115, 9788186539118*
4. Summerfield M.A. (1991): Global geomorphology: An introduction to the study of landforms. Longman Scientific and Technical, 547p. *ISBN: 0-582-30156-4*.

Learning Outcomes

- CO1.** Theories related to the genesis of the earth and its association with other planetary bodies of the solar system. (Knowledge Level: Remembering & Understanding)
- CO2.** Understanding of earth's surface and sub-surface process and resulting landforms. (Knowledge Level: Understanding)
- CO3.** Analysis of different landforms and role of active crustal weathering agents to unfold the physiochemical processes of the earth's surface. (Cognitive Level: Analysing)
- CO4.** Exercise on the modern tools and techniques for structural analysis of surface landforms and their relationship with the surrounding. (Cognitive Level: Evaluating and Creating)
- CO5.** Importance of different landforms in the sustainable development of society and the nation. (Cognitive Level: Applying)

GM12: STRUCTURAL GEOLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This paper introduces students to topographic and geological maps and their applications. It emphasizes the genesis and deformation of primary and secondary geological structures, familiarizing students with their geometry and elements from micro- to meso-scale, and their interpretation in maps and field studies.

Syllabus

Course Content
Primary and Secondary structures, structures and topography, cleavage and schistosity, relationship of cleavage with other structures. Nature of foliation and lineation and its relationship with major structures. Fold elements, terminology and fold classification, mechanics of folding. Classification and origin of joints, veins, relation to other structures. Shear zone, nature and types of shear zone, shear sense indicators. Faults, terminology and classification, structures associated with faults. Thrusts and nappe structures, dome and basin structures.

Texts / Reference Books

1. Davis G.H. and Reynolds S.J. and Kluth C.F. (2011): Structural Geology of Rocks and Regions (3rd Edition). John Wiley and Sons. Inc., 864p. *ISBN: 978-0471152316*.
2. Fossen H. (2016): Structural Geology (2nd ed). Cambridge University Press, 510p. *ISBN-13: 978-1107057647*.
3. Ragan D.M. (2009): Structural Geology: An Introduction to Geometrical Techniques (4th Edition). Cambridge University Press, 632p. *ISBN: 978-0521745833*.
4. Twiss, R.J. and Moores, E.M. (2007) Structural Geology (2nd ed). Cambridge University Press, New York, 532 p. *ISBN 978-0716749516*.

Learning Outcomes

- CO1.** Fundamentals of earth's interior and exterior structures with the stress and strain perspective. (Knowledge Level: Remembering & Understanding)
- CO2.** Decoding the existing structures and stress phenomena on different scales. (Cognitive Level: Understanding)
- CO3.** Conventional and advanced tools and techniques to analyse and interpret common geological structures. (Cognitive Level: Analysing and Evaluating)
- CO4.** Significance of different geological structures in risk and hazard as a prerequisite for the development of a project. (Cognitive Level: Evaluating and Solving Problems)
- CO5.** Field evidence for the structural deformation and its representation in the compilation of a scientific report. (Cognitive Level: Applying and Creating)

GM13: INTRODUCTION TO GEOPHYSICS

Credits	Lecture /Tutorial
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01 Credit	01 Hour/Week
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Course Objectives

The students will be able to recognize the physical characteristics of geological phenomena of the earth crust with the help of simple geophysical techniques. The paper will enable the students to get the subsurface information derived by scientific subsurface models.

Syllabus

Course Content
Role of geophysical data in geological studies. Stress, Strain, Young's modulus, Rigidity modulus, Bulk modulus, Compressibility, Poisson's ratio; Seismic body and Surface waves; Elastic rebound model, seismograph, Location of the epicenter of an earthquake, Global Seismicity, Earthquake intensity and magnitude, Frequency and energy released, Earthquake prediction. Fundamentals of Gravity method and Magnetic methods, Electrical Resistivity Method, Principle of Seismic Refraction method and Seismic Reflection method.

Texts / Reference Books

1. Dobrin M.B. and Savit C.H. (1988): An introduction to Geophysical Prospecting (4th Edition McGraw-Hill Education, 867p. ISBN: 978-0070171961.
2. Lowrie W. (2007): Fundamentals of geophysics. Cambridge University Press. 391p. ISBN: 9780511352737.
3. Reynolds J.M. (1998): An introduction to Applied and Environmental Geophysics. John Wiley and Sons, England, 796p. ISBN: 0-471-96802.
4. Telford W.M., Geldart, L.P. and Sheriff R.E. (1990): Applied geophysics (2nd Edition). Cambridge university press, 770p. ISBN: 9781139167932.

Learning Outcomes

- CO1.** Understanding of basic physical properties of the earth with established geophysical methods. (Knowledge Level: Remembering & Understanding)
- CO2.** Analyse the relationship between gravity potential and the shape of the earth. (Cognitive Level: Analysing)
- CO3.** Interpretation of the gravity, magnetic, electric and seismic properties of earth and rocks for resource estimation. (Cognitive Level: Evaluating and Applying)
- CO4.** Significance of different geophysical methods for the exploration of natural resources for mankind and national development. (Cognitive Level: Applying)
- CO5.** Perform lab analysis for compilation of gravity data for interpretation to achieve natural resources and for civil development projects. (Cognitive Level: Applying and Creating)
- CO6.** Teamwork for performing and handling elements of geophysical data. (Cognitive Level: Problem Solving)

GMP1: PRACTICAL-I		
Credits	Practical	Marks
01 Credit	02 Hours/Week	20 Marks

Course Objectives

This practical course introduces students to topographic and geological maps and their applications. It emphasizes the genesis and deformation of primary and secondary geological structures, familiarizing students with their geometry and interpretation from micro- to meso-scale, both in maps and in the field.

Practical/Field Exercise

Course Content
• Surface topographic representation techniques and visualization of features in toposheets and maps. • Problems of dip, strike and thickness of bed, true dip and apparent dip, pitch, plunge, lines and intersecting planes. • Contour maps and interpretation of geological structures from maps, geological history, completion of outcrops: three-point problem • Exercises on various structural geological problems by graphical and stereographic projection, structural analysis • Field surveys techniques and processes.

Learning Outcomes

- CO1.** Develop skills to read, prepare, and interpret topographic and geological maps. (Knowledge Level: Understanding & Applying)
- CO2.** Identify, measure, and analyse primary and secondary geological structures using field and laboratory methods. (Cognitive Level: Applying & Analysing)
- CO3.** Demonstrate the use of conventional tools (compass clinometer, stereonet, etc.) for structural analysis. (Cognitive Level: Applying)
- CO4.** Interpret micro- to meso-scale structural data and represent them graphically and cartographically. (Cognitive Level: Analysing & Creating)
- CO5.** Compile structural field data into scientific reports with emphasis on deformation patterns and their implications. (Cognitive Level: Evaluating & Creating)
- CO6.** Work collaboratively in the field and lab to conduct structural surveys and present outcomes effectively. (Cognitive Level: Problem Solving & Teamwork)

GEOLOGY MINOR SEMESTER-II

GM21: CRYSTALLOGRAPHY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

The course aims to develop a fundamental understanding of crystallography by introducing students to the principles of crystal lattices, internal structures and the geometrical arrangement of crystal faces. It seeks to familiarize students with the symmetry elements governing crystals and provide the basis for recognizing and interpreting crystal forms as the framework for studying rock-forming minerals.

Syllabus

Course Content
Fundamentals of a crystal and crystal systems; their faces, forms and laws of crystallography; crystal bonding. Symmetry elements of crystals; notations and indices; Bravais lattices; Miller notation, Hermann-Mauguin symbols; study of crystal forms of different crystal systems. Spherical and stereographic projection and their uses. Space Lattice and Symmetry of internal structures. Morphology of minerals.

Texts / Reference Books

1. Deer W.A., Howie R.A. and Zussman J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). Prentice Hall, London, 510p. ISBN: 978-0903056274.
2. Klein C. (2007): Minerals and Rocks (3rd Edition). John Wiley and Sons New York, 456p. ISBN: 978-0471772774.

Learning Outcomes

- CO1.** Nomenclature of major crystal systems with different measurement and analytical techniques. Classification of common minerals and their association in different rocks. (Cognitive Level: Understanding)
- CO2.** Learn graphical depiction of a crystal and geochemical representation of common minerals. (Cognitive Level: Analysing and Creating)
- CO3.** Availability and spatiotemporal distribution of common mineral and their role in the development of nation and mankind. (Cognitive Level: Evaluating and Applying)
- CO4.** Perform lab analysis for optical and physical properties of a mineral. Prepare crystal models individually and in a team under the constant supervision of experts. (Cognitive Level: Evaluating and Applying)
- CO5.** Represent the findings of analysis professionally in the form of reports, and oral or visual presentations of data. (Cognitive Level: Analysing and Creating)

GM22: MINERALOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

The course aims to provide students with a comprehensive understanding of mineralogy by focusing on the physico-chemical properties, origin, formation processes, and occurrence of minerals, with special emphasis on rock-forming minerals. Students will also learn the fundamentals of mineral paragenesis and optical properties, enabling them to analyse and interpret the characteristics and genesis of minerals in geological contexts.

Syllabus

Course Content
Introduction to minerals, their classification and various compositional groups (silicates, oxides, phosphates, sulphates and sulphides etc.) Mineralogy of major rock-forming minerals; Silicate and non-silicate structures; CCP and HCP structures. twinning and its important laws; common types of twins and their examples. Nature of light and principles of optical mineralogy.

Texts / Reference Books

1. Deer W.A., Howie R.A. and Zussman J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). Prentice Hall, London, 510p. ISBN: 978-0903056274.
2. Klein C. (2007): Minerals and Rocks (3rd Edition). John Wiley and Sons New York, 456p. ISBN: 978-0471772774.
3. Klein C. and Hurlbut C. S. Jr (1993): Manual of Mineralogy (21st Edition). John Wiley New York, 681p. ISBN: 0-471-59955-7.
4. Klein C. and Philpotts A., (2016): Earth Materials: Introduction to Mineralogy and Petrology (2nd Ed), Cambridge University Press, 616p., ISBN-13 : 978-1316608852
5. Read H.H. (1970): Rutley's Element of Mineralogy (26th Edition). Springer Netherlands, 560p. ISBN: 978-94-011-9769-4, 9780045490059.

Learning Outcomes

- CO1.** Introduction and understanding of natural minerals and their physiochemical behaviour, their process of crystallisation in specific crystal groups. (Knowledge Level: Remembering & Understanding)
- CO2.** Nomenclature of major crystal systems with different measurement and analytical techniques. Classification of common minerals and their association in different rocks. (Cognitive Level: Understanding)
- CO3.** Learn graphical depiction of a crystal and geochemical representation of common minerals. (Cognitive Level: Analysing and Creating)
- CO4.** Availability and spatiotemporal distribution of common minerals and their role in the development of nation and mankind. (Cognitive Level: Evaluating and Applying)
- CO5.** Environmental impacts and association of common minerals in the lithosphere, hydrosphere and atmosphere. (Cognitive Level: Problem Solving)

GM23: IGNEOUS PETROLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This course introduces the classification, origin, evolution, and field occurrence of igneous rocks. It explores magmatic processes, tectonic settings, phase equilibria, and geochemical tools used in petrology. Laboratory work emphasizes hand specimen identification, thin section petrography, and geochemical data interpretation.

Syllabus

Course Content
Igneous Rocks & Rock Cycle, Classification of Igneous Rocks; Magma and magmatic bodies: Magma generation in the crust and upper mantle. Physical properties of magma - temperature, viscosity, density and volatile content. Genesis, properties, emplacement and crystallization of magmas. Bowen's reaction Series and its application, Magmatic differentiation- fractional crystallization, partial melting, assimilation and their role in magmatic differentiation. Mode of occurrence of igneous rocks. Forms of igneous rocks. Igneous Rock Suites: Ophiolites & Island Arcs, Continental Igneous Provinces

Texts / Reference Books

1. Best M.G. (2002): Igneous and Metamorphic Petrology. Blackwell Science Blackwell Science Ltd., 2003; ISBN: 1-40510-588-7; 752p.
2. Philpotts, A.R. and Ague, J.J. (2018): Principles of Igneous and Metamorphic Petrology, Cambridge University Press, Cambridge, United Kingdom. ISBN13 9780521880060.
3. Winter J.D. (2010): Principles of Igneous and Metamorphic Petrology. Prentice-Hall of India Pvt. Ltd., Prentice Hall, 728p. ISBN: 9788120343979, 9788120343979.
4. Klein C. and Philpotts A., (2016): Earth Materials: Introduction to Mineralogy and Petrology (2nd Ed), Cambridge University Press, 616p., ISBN-13 : 978-1316608852

Learning Outcomes

- CO1.** Classify and identify igneous rocks in hand samples and thin sections. (Knowledge Level: Remembering & Understanding)
- CO2.** Understand the origin and evolution of magmas. (Cognitive Level: Understanding)
- CO3.** Interpret phase diagrams related to igneous systems. (Cognitive Level: Analysing and Evaluating)
- CO4.** Use geochemical tools to analyse igneous processes and tectonic settings. (Cognitive Level: Evaluating and Creating)

GMP2: PRACTICAL-II

Credits	Practical	Marks
01 Credit	02 Hours/Week	20 Marks

Course Objectives

This practical course introduces students to topographic and geological maps and their applications. It emphasizes the genesis and deformation of primary and secondary geological structures, familiarizing students with their geometry and interpretation from micro- to meso-scale, both in maps and in the field.

Practical/Field Exercise

Course Content
• Identification of major rock-forming minerals in hand specimens • Study of optical properties of minerals using a polarizing microscope • Thin section study of common minerals (olivine, pyroxene, amphibole, mica, feldspar, quartz) • Basic study of crystal symmetry, systems, and crystal forms • Introduction to crystallographic measurements and projection • Study of igneous rocks in hand specimens and thin sections • Identification of igneous structures and textures • Basic understanding of thin section preparation

Learning Outcomes

- CO1.** Identify and describe major rock-forming minerals in hand specimens and understand their basic physical properties. (Knowledge Level: Remembering & Understanding)
- CO2.** Examine and interpret the optical properties of minerals using a polarizing microscope. (Cognitive Level: Understanding & Applying)
- CO3.** Analyze thin sections of common rock-forming minerals such as olivine, pyroxene, amphibole, mica, feldspar, and quartz. (Cognitive Level: Applying & Analysing)
- CO4.** Understand crystal symmetry, crystal systems, and crystal forms, along with basic crystallographic measurements and projections. (Knowledge Level: Understanding & Applying)
- CO5.** Identify igneous rocks and interpret their structures and textures in hand specimens and thin sections, along with basic knowledge of thin section preparation. (Skill Level: Applying, Analysing & Understanding)

GEOLOGY MINOR SEMESTER-III

GM31: SEDIMENTOLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This course introduces students to the fundamental concepts of sedimentary processes and their role in the rock cycle. It emphasizes surface processes, weathering of rocks, and the formation of sediments, along with the development of sedimentary textures and structures. The course covers the classification of sedimentary rocks, including clastic, chemical, and biochemical types, and examines their origin, composition, and diagenesis. It also familiarizes students with basic principles of hydraulics, sediment transport mechanisms, and the interpretation of sedimentary structures.

Syllabus

Course Content
Study of surface processes and weathering of rocks; sedimentary textures; classification of sedimentary rocks including conglomerates, sandstones, shales, carbonate rocks, ironstones, chert, and evaporites; provenance of clastic sediments; diagenesis of siliciclastic and carbonate rocks; basic elements of hydraulics and sediment transport processes; identification and interpretation of important sedimentary structures; introduction to sedimentary facies, depositional environments, and sedimentary basins.

Texts / Reference Books

1. Lindholm R.C. (1987): A Practical Approach to Sedimentology. Allen and Unwin, London, 276p.
2. Miall A.D. (2000): Principles of Sedimentary Basin Analysis. Springer-Verlag, 628p. ISBN-10: 3540657908
3. Prothero D.R. and Schwab F. (2004): Sedimentary Geology. Freeman, 600p. ISBN-10-716739054.
4. Reading H.G. (1997): Sedimentary Environments and facies. Blackwell Scientific Publication, ISBN 0-632-03627-3.
5. Sengupta S.M. (2007): Introduction to sedimentology. CBS Publ, New Delhi, 339p., ISBN 81-239-1491-1.

Learning Outcomes

- CO1.** Explain the processes of rock weathering, sediment generation, and the development of sedimentary textures. (Knowledge Level: Remembering & Understanding)
- CO2.** Classify sedimentary rocks such as conglomerates, sandstones, shales, carbonate rocks, ironstones, chert, and evaporites based on their composition and origin. (Cognitive Level: Understanding & Analysing)
- CO3.** Analyse the provenance of clastic sediments and interpret diagenetic processes in siliciclastic and carbonate rocks. (Cognitive Level: Analysing & Evaluating)
- CO4.** Interpret sediment transport mechanisms, sedimentary structures, and flow regimes using principles of hydraulics. (Cognitive Level: Applying & Analysing)
- CO5.** Evaluate sedimentary facies and depositional environments, and understand the formation and evolution of sedimentary basins. (Cognitive Level: Evaluating & Creating)

GM32: METAMORPHIC PETROLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This course introduces students to the basic concept of metamorphism and its role in the rock cycle. It emphasizes the effects of temperature and pressure on rocks, the development of common metamorphic textures, structures, and minerals, and the identification of metamorphic zones and isograds. The course also familiarizes students with simple metamorphic reactions, mineral changes, and their relation to thermodynamic principles, along with an understanding of metamorphism in relation to plate tectonics and mountain building processes.

Syllabus

Course Content
Introduction to Metamorphism, its role in the rock cycle, temperature and pressure agents, contact and regional metamorphism; metamorphic textures and structures, changes in grain size, and features like layering (foliation) and banding, isograds. metamorphic path in evolution of mineral assemblages. Chemographic Diagrams, Introduction to common minerals formed during metamorphism and metamorphic zones. thermodynamic principles of metamorphic reactions, metamorphic reactions, metamorphism and plate tectonics, Paired Metamorphic Belts.

Texts / Reference Books

1. Best M.G. (2002): Igneous and Metamorphic Petrology. Blackwell Science Blackwell Science Ltd., 2003; ISBN: 1-40510-588-7; 752p.
2. Bucher, K. and Grapes, R. (2010): Petrogenesis of Metamorphic Rocks, Springer.
3. Philpotts A., & Ague J. (2022): Principles of Igneous and Metamorphic Petrology (3rd edition). Cambridge University Press. ISBN 978-1-108-49288. doi:10.1017/9781108631419.
4. Spear F.S. (1995) Metamorphic Phase Equilibria and Pressure-Temperature-Time-Paths. Mineralogical Society of America Monograph. ISBN: 0-939950-34-0. 799; p.
5. Winter J.D. (2014): Principles of Igneous and Metamorphic Petrology (2nd edition), Pearson Education Limited, ISBN 13: 978-1-292-02153-9; 745p.

Learning Outcomes

- CO1.** Explain the basic concept of metamorphism, its role in the rock cycle, and the influence of temperature and pressure. (Knowledge Level: Remembering & Understanding)
- CO2.** Identify common metamorphic textures, structures, minerals, and metamorphic zones including isograds. (Cognitive Level: Understanding)
- CO3.** Interpret simple changes in mineral assemblages and metamorphic paths using basic concepts and diagrams. (Cognitive Level: Analysing)
- CO4.** Explain basic metamorphic reactions, thermodynamic principles, and their relation to geological processes. (Cognitive Level: Understanding & Evaluating)
- CO5.** Relate metamorphism to plate tectonics and recognize its significance in mountain building and paired metamorphic belts. (Cognitive Level: Applying & Understanding)

GM33: GEO-TECTONICS

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This course introduces students to the fundamental concepts of geotectonics, including plate tectonics, continental drift, and sea-floor spreading, along with Earth's internal structure and isostasy. It enables understanding of tectonic processes, mountain building, earthquakes, and sedimentary basin development, supported by modern techniques like GPS and plate reconstruction.

Syllabus

Course Content
Definition and scope of geotectonics, Historical development of tectonic theories, Earth's internal structure, Concept of isostasy, continental drift and Sea-Floor Spreading: Wegener's theory of continental drift, Sea-floor spreading hypothesis (Hess's theory), Magnetic anomalies and paleomagnetism. Mid-ocean ridges, trenches, seamounts. Plate boundaries: divergent, convergent, transform, Plate interactions and driving mechanisms, Hotspots and mantle plumes, Triple junctions and plate configurations, Orogenic Belts and Mountain Building. Evolution of mountain chains and structural trends, e.g. Himalayas, Andes, Alps. Fault types and earthquake generation, classification of sedimentary basin, tectonic control on sedimentation, Basin subsidence mechanisms, plate reconstructions and supercontinent cycles, GPS and geodetic measurements in tectonic studies, Neotectonics and active tectonics.

Texts / Reference Books

1. Burbank D.W. and Anderson R.S. (2011): Tectonic Geomorphology (2nd Edition). Wiley-Blackwell, 460p. ISBN: 978-1-444-33887-4
2. Condie, Kent. C. (1989): Plate Tectonics and Crustal Evolution (3rd Edition). Butterworth-Heinemann Ltd., 375p. ISBN: 978-0080348735.
3. Davies G.F. (1999): Dynamic Earth: Plates, Plumes and Mantle Convection. Cambridge University Press, 472p. ISBN: 978-0521599337.
4. Kearey P., Klepeis K.A. and Vine F.J. (2009): Global Tectonics (3rd Edition). Wiley-Blackwell, 496p. ISBN: 978-1-405-10777-8.
5. Keller E.A and Pinter N. (2001): Active Tectonics: Earthquakes, Uplift, and Landscape (2nd Edition). Pearson Publications, 384p. ISBN: 978-0130882301.
6. Moores, E.M., & Twiss, R.J. – Tectonics
7. Windley B. (1995): The Evolving Continents (3rd Edition). Wiley-Blackwell, 544p. ISBN: 978-0471917397.

Learning Outcomes

- CO1.** Understand the fundamental concepts of geotectonics, including Earth's internal structure, isostasy, and the evolution of tectonic theories. (Cognitive Level: Remembering & Understanding)
- CO2.** Analyse the processes of continental drift, sea-floor spreading, and plate tectonics using paleomagnetic and geophysical evidence. (Cognitive Level: Analysing)
- CO3.** Evaluate the mechanisms of mountain building, faulting, earthquake generation, and tectonic control on sedimentary basin development. (Cognitive Level: Evaluating)
- CO4.** Apply modern techniques such as GPS, geodetic measurements, and plate reconstruction models in understanding crustal dynamics and supercontinent cycles. (Cognitive Level: Applying & Creating)

- CO5.** Develop problem-solving skills in analysing neotectonic activities and active tectonic processes for hazard assessment and geological interpretation. (Cognitive Level: Problem Solving)

GMP3: PRACTICAL-III		
Credits	Practical	Marks
01 Credit	02 Hours/Week	20 Marks

Course Objectives

This practical course helps students study sedimentary and metamorphic rocks using hand specimens and thin sections, along with basic lab techniques like grain size analysis. It focuses on identifying rock features, structures, and minerals to understand how rocks form and change. The course also builds skills in petrographic analysis and interpreting geological history.

Practical/Field Exercise

Course Content
• Study of rocks in hand specimens and in thin sections • Study of sedimentary structures and Paleo-current analysis • Clastic grain-size analysis • Roundness and shape analyses of clastic grains • Identification of metamorphic rocks in hand specimens • Thin Section Petrography • Mineral Chemistry and Pleochroism • Metamorphic Facies Interpretation • Reaction Texture Identification • Identification of secondary structures and its interpretation.

Learning Outcomes

- CO1.** Identify and describe sedimentary and metamorphic rocks in hand specimens and thin sections, including petrographic characterization and mineral identification. (Cognitive Level: Understanding & Applying)
- CO2.** Perform clastic grain-size, roundness, and shape analysis along with sedimentary structure interpretation and paleocurrent analysis to reconstruct depositional environments. (Cognitive Level: Applying & Analysing)
- CO3.** Analyze mineral chemistry, pleochroism, reaction textures, and metamorphic facies to understand mineralogical variations and metamorphic conditions. (Cognitive Level: Analysing & Evaluating)
- CO4.** Interpret secondary structures and integrate petrographic, sedimentological, and structural data to reconstruct geological history. (Cognitive Level: Evaluating & Creating))

GEOLOGY MINOR SEMESTER-IV

GM41: STRATIGRAPHY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

Stratigraphy helps us understand Earth's history by studying the order and distribution of rock layers over time and space. These rock layers preserve records of past events, climates, and environments. In this course, students will learn the basic principles of stratigraphy and study the major geological records of India.

Syllabus

Course Content
Basic principles and definitions of stratigraphic classification and Nomenclature; Brief account on Magnetostratigraphy; Stratigraphic correlation. Dharwar, Singhbhum, Bastar, Aravalli and Bundelkhand Cratons Proterozoic sedimentary basins of India, Mobile Belts of India. Paleozoic Era: Paleogeographic, paleoclimatic and tectonic set up. A detailed study of succession, age and depositional environments, Tethys Himalaya and Lesser Himalaya Ranges; Gondwana sequences. Mesozoic Era: Paleogeographic, paleoclimatic and tectonic set up. A detailed study of succession, lithology, age, depositional environments of various formations of Extra-peninsular and Peninsular India. Cenozoic Era: Paleogeographic, paleoclimatic and tectonic set up along with Himalayan Orogeny. A detailed study of succession, age, depositional environments of various Paleogene and Neogene formations of Extra-peninsular and Peninsular India; Siwalik Supergroup. Deccan Traps: distribution, petrology and age.

Texts / Reference Books

1. Krishnan M.S. (2012): Geology of India and Burma (6th Edition). CBS Publishers and Distributors, 536p. ISBN: 8123900120, 978-8123900124.
2. Kumar R. (2018): Fundamental of Historical Geology and Stratigraphy of India. New Age Intl. Publishers, New Delhi, 268p. ISBN: 0852267452, 978-0852267455.
3. Nichols G. (2009): Sedimentology and Stratigraphy (2nd Edition). Blackwell Science, Oxford, 433p. ISBN: 978-1-4051-9379-5.
4. Ramakrishnan M., and Vaidyanadhan R. (2008): Geology of India (Volume-1), Geological Soc. of India, Bangalore, 556p. ISBN: 978-81-85867-98-4.
5. Ramakrishnan M., and Vaidyanadhan R. (2008): Geology of India (Volume-2), Geological Soc. of India, Bangalore, 428p. ISBN: 978-81-85867-98-4.

Learning Outcomes

- CO1.** Understanding the basic principles, classification, nomenclature, and correlation methods of stratigraphy, including magnetostratigraphy and graphic correlation. (Cognitive Level: Understanding)
- CO2.** Analyse the stratigraphic succession of Precambrian cratons, Proterozoic basins, and mobile belts of India. (Cognitive Level: Analysing)

- CO3.** Evaluate the paleogeographic, paleoclimatic, and tectonic settings of the Paleozoic, Mesozoic, and Cenozoic eras with reference to Indian stratigraphy. (Cognitive Level: Evaluating and Applying)
- CO4.** Interpret lithology, depositional environments, fossil content, and economic importance of major stratigraphic formations of India. (Cognitive Level: Evaluating and Applying)
- CO5.** Develop the ability to present and correlate stratigraphic data, including special studies of Deccan Traps and associated formations, through reports and visual representations. (Cognitive Level: Analysing and Creating)

GM42: PALEONTOLOGY

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

The course aims to introduce students to the fundamentals of paleontology, including fossils, their types, preservation, and significance. It focuses on major fossil groups, their evolution, and basic morphology, along with the principles of paleoecology and taphonomy. The course also highlights the use of fossils in understanding Earth's history and past environments.

Syllabus

Course Content
Introduction: Definition, subdivision and scopes of Paleontology Fossils: Definition, character, kinds (body and trace) and applications. Conditions and modes of fossilization. Classification and nomenclature. Concept of species. Paleoecology; concepts and approaches. Taphonomy. Megafossils: Study of morphological characters and geological distribution of major vertebrate and invertebrate groups. Introduction to paleobotany with special reference to Gondwana plant fossils. Microfossils: Elements of micropaleontology and its practical applications. Collection and preparation of microfossils. Types of microfossils.

Texts / Reference Books

1. Benton M.J. (1990): Vertebrate Paleontology. Unwin Hyman, London, 452p. ISBN: 0-632-05614-2.
2. Clarkson E.N.K. (1998): Invertebrate Palaeontology and Evolution, ELBS/Allen and Unwin, London, 382p. ISBN: 0-04-560010-4.
3. Haq B.U. and Boersma A. (1998): Introduction to Marine Micropaleontology, Elsevier, 376 pages, ISBN: 0444826726.
4. Moore R.C., Lalicker C. G. and Fischer A.G. (1997): Invertebrate Fossils, CBS Publ., N. Delhi. CBS Publishers and Distributors Private Ltd., 2004; ISBN: 8123911394, 766p.
5. Prothero D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Edition), McGraw Hill.
6. Raup D.M. and Stanley S.M. (1985): Principles of Palaeontology (CBS Publications), W.H. Freeman and Company, New York, 481 pages.
7. Saraswati P.K. and Srinivasan M.S. (2016): Micropaleontology: Principles and Applications, Springer.
8. Shrock R.R. and Twenhofel W.H. (1999): Principles of Invertebrate Paleontology, CBS Publ., N. Delhi. Textbook Publishers, 816p. ISBN: 075818395X, 9780758183958.
9. Wood H. (1997): Paleontology Invertebrate (9th Edition), CBS Publ., N. Delhi.

Learning Outcomes

- CO1.** Understand the basic concepts of paleontology, types of fossils, and processes of fossil formation. (Knowledge Level: Remembering & Understanding)
- CO2.** Identify common fossil groups and describe their basic features and geological significance. (Cognitive Level: Understanding & Applying)
- CO3.** Explain the evolution of life through fossil records, including plants and vertebrates. (Cognitive Level: Understanding & Analysing)
- CO4.** Recognize different types of microfossils and their role in studying past environments and geological time. (Cognitive Level: Understanding & Applying)
- CO5.** Appreciate the importance of fossils in reconstructing Earth's history, climate, and evolution. (Cognitive Level: Analysing & Evaluating)

GM43: COMPUTER PROGRAMMING IN GEOSCIENCES

Credits	Lecture /Tutorial
01 Credit	01 Hour/Week

Course Objectives

This course introduces the basics of computer systems and their applications, including essential software tools such as word processing, spreadsheets, and presentations. It covers fundamental programming concepts and focusing on problem-solving and logical thinking. The course also provides a basic understanding of algorithms and an introductory overview of machine learning concepts and their applications.

Syllabus

Course Content
Basics of Computer: Introduction to computers and their parts (CPU, memory, input/output devices). Simple idea of number systems and how data is stored. Basic understanding of how programs work. Introduction to flowcharts and simple algorithms.
Basic Computer Applications: Practical use of MS Word (typing and formatting), MS Excel (basic calculations and tables), and PowerPoint (making presentations). Introduction to simple drawing and graphics tools.
Introduction to Programming (C++): Basic concepts of programming such as variables, data types, input/output, and simple operations. Use of conditions (if-else) and loops. Writing and running simple programs.

Texts / Reference Books

- Buttkus B. (2000). Python for geosciences. Springer. ISBN: 9783540662695.
- de Smith M.J., Goodchild M.F. and Longley P.A. (2023). Geospatial analysis: A comprehensive guide to principles, techniques and software tools (7th ed.). ISBN (Print): 9781905839934.
- Pimpler E. (2015). Programming ArcGIS with Python Cookbook (2nd ed.). Packt Publishing. ISBN: 9781785282898.
- Robert L. (1999) Object Oriented Programming C++, Galgotia Publication, ISBN: 8185623228.
- Sarma D.D. (2009) Geostatistics With Applications in Earth Sciences (2nd Ed), Springer Nature, 205p, ISBN-13: 978-1402093791.

Learning Outcomes

- CO1.** Understand the basic components of computer systems, number systems, and data representation. (Knowledge Level: Remembering & Understanding)
- CO2.** Apply basic computer applications such as Word, Excel, and PowerPoint for academic and scientific purposes. (Cognitive Level: Applying)
- CO3.** Develop simple programs using C++ by applying fundamental programming concepts and control structures. (Cognitive Level: Applying & Analysing)
- CO4.** Demonstrate basic problem-solving skills using Python programming. (Cognitive Level: Applying)

GMP4: PRACTICAL-IV

Credits	Practical	Marks
01 Credit	02 Hours/Week	20 Marks

Course Objectives

This practical course introduces students to the study of fossils through hand specimens and microscopic analysis, focusing on their modes of occurrence, morphology, and functional significance. It emphasizes the identification and interpretation of invertebrate fossils, Gondwana plant fossils, and microfossils, along with techniques of preparation, mounting, and sketching. The course also develops essential computer skills, including document preparation, data analysis, presentation design, and basic programming.

Practical/Field Exercise

Course Content
Paleontology: Study of specimens illustrating various modes of occurrence of fossils. • Study of morphological characters of some important Invertebrate fossil genera. • Study of functional morphology of bivalvia shells. • Study of morphological characters of some important Gondwana plant fossils. • Preparation, picking and mounting of microfossils. • Microscopic study of various types of microfossils. • Microscopic study and sketching of important planktic and benthic foraminiferal genera. Computer Programming: • MS Word: Create and format text documents, add images, and design simple forms. • MS Excel: Perform calculations, create graphs, and analyze data. • PowerPoint: Design slideshows, add animations, and present ideas. • C++ Programming: Write small programs, use loops and conditions, handle file I/O, and debug basic syntax issues.

Learning Outcomes

- CO1.** Develop skills in creating, formatting, and presenting scientific data using MS Word, Excel, and PowerPoint, including preparation of reports, graphical analysis, and effective visual communication. (Cognitive Level: Understanding, Applying & Creating)
- CO2.** Identify and describe modes of occurrence, preservation, and morphological characteristics of important invertebrate fossils and Gondwana plant fossils through hand specimen study. (Cognitive Level: Remembering & Understanding)

- CO3.** Apply analytical skills to interpret functional morphology of bivalve shells and perform basic data analysis using MS Excel for geological and fossil-based datasets. (Cognitive Level: Applying & Analysing)
- CO4.** Develop practical competencies in preparation, mounting, and microscopic examination of microfossils, along with basic programming skills in C++ for data handling and problem-solving. (Skill Level: Applying & Analysing)
- CO5.** Integrate observational, analytical, and computational skills to interpret microfossil features (planktic and benthic) and present findings through structured reports, presentations, and simple programming outputs. (Cognitive Level: Analysing, Evaluating & Creating)

