COURSE CURRICULUM FOR B.Sc. (HONOURS) GEOLOGY

AS PER NATIONAL EDUCATION POLICY (NEP) 2020

DEPARTMENT OF GEOLOGY
JAGANNATH BAROOAH COLLEGE (AUTONOMOUS)
JORHAT (ASSAM)

(Approved by Board of Studies on 16/03/2024
And
(9th Academic Council on May, 04, 2024)

PREAMBLE

The main objective of the four-year geology degree programme is to create skilled professionals who can serve society, plan for optimal use of earth resources and at the same time protect the Earth. This curriculum is structured based on the NEP 2020 requirements, which include the fundamentals, key ideas, and practical aspects of geology. It aspires to enable students to explore and understand the Earth by employing a learning outcome-based curriculum. It prepares students for academic and industrial prospects by encouraging them to inculcate critical thinking, analytical abilities, and interdisciplinary knowledge. In addition, it includes guidance on maintaining physical and emotional well-being and promoting social justice and sustainability.

PROGRAMME OUTCOMES (POs)

The Four-Year Undergraduate Programme (FYUGP), in geology is designed to fulfill the following objectives.

- Students are expected to understand the basics of geology, its scope, and its various branches, gain insights into fundamental aspects of the Earth and planetary systems and their changes over time. They will also learn the key geological concepts of mineralogy, petrology, structural geology, plate tectonics, stratigraphy, geochemistry, palaeontology, and various mineral exploration methods, as well as the origin and distribution of economic minerals and energy resources.
- They are also expected to gain understanding of environmental issues related to the planet Earth. They will also gain understanding about different form and processes of landforms evolution, sources of natural resources, including hydrocarbons, groundwater, and ores.
- Students will be able to participate in geological fieldwork to observe actual geological exposures, features etc., learn data collection techniques, measurements, and interpretation skills. This is expected to enhance their knowledge on geologic field mapping.

COMMON NEP, 2020 STRUCTURES OF J.B. COLLEGE (AUTONOMOUS)

Programme offered by the Department: B Sc (Hons)

Types of Course offered by the Department

1. Major Course
2. Minor Course
3. Multidisciplinary
4. Skill Enhancement Course (SEC)
5. Internship/Community Engagement
6. Dissertation/ Thesis

Credit Distribution of different courses

Semester	Major	Minor	Multi-Disciplinary	SEC	Intern	Dissertation /Thesis
1	4	4	3	3		
2	4	4	3	3		
3	4+4+4	4	3	3		
4	4+4+4+4	4			2	
5	4+4+4+4	4			2	
6	4+4+4+4+2	4				
7	4+4+4+4	4				2
8	4+4	4				10
Total	**94**	**32**	**09**	**09**	**04**	**12**

Semester wise Distribution of Course and Credit in Geology

Sem.	Major Course (Credit)	Minor Course (Credit)	Multi-	SEC (Credit)
			Disciplinary Course (Credit)	
1	Fundamentals of Earth System Science I (4)	Fundamentals of Earth System Science I (4)	Introduction to Earth Sciences (3)	Laboratory Techniquessoil, water, and survey (3)
2	Fundamentals of Earth System Science II (4)	Fundamentals of Earth System Science II (4)	Introduction to Earth Sciences (3)	Laboratory Techniquessoil, water, and survey (3)
3	Mineral Science (4) Structural Geology (4) Elements of Geochemistry (4)	Rocks and Minerals (4)	Introduction to Earth Sciences (3)	Laboratory Techniquessoil, water, and survey (3)
4	Igneous Petrology (4) Sedimentary Petrology (4) Paleontology (4) Principles of Stratigraphy (4)	Historical Geology (4)		
5	Metamorphic Petrology (4) Stratigraphy of India (4) Hydrogeology and Oceanography (4) Economic Geology (4)	Earth Resources (4)		
6	Geodynamics and Tectonics (4) Engineering Geology (4) Remote Sensing and GIS (4) Geomorphology (4) Geological Field Work (2)	Climate and Environmental Geology (4)		
7	Exploration and Mining Geology (4) Fuel Geology (4) River Science (4) Earth Climate and Environment (4)			Research Methodology (2)
8	Basin Analysis (4)* Geostatistics and Data Analysis in Earth Sciences (4) Evolution of life through time (4)* Geology of North East India (4)			Project Work (2) Or Dissertation (10)

GEOLOGY COURSE STRUCTURE

Major Course

Semester	Course Code	Credit	Course Title	Course Type and Credit (Theory 3 + Practical 1)	Marks Distribution			
					TH	PR	IA	Total
1st	GEOMJ-011	4	Fundamentals of Earth System Science I	Theory + Practical	50	20	30	100
2nd	GEOMJ-021	4	Fundamentals of Earth System Science II	Theory + Practical	50	20	30	100
3rd	GEOMJ-031	4	Mineral Science	Theory + Practical	50	20	30	100
	GEOMJ-032	4	Structural Geology	Theory + Practical	50	20	30	100
	GEOMJ-033	4	Elements of Geochemistry	Theory + Practical	50	20	30	100
4th	GEOMJ-041	4	Igneous Petrology	Theory + Practical	50	20	30	100
	GEOMJ-042	4	Sedimentary Petrology	Theory + Practical	50	20	30	100
	GEOMJ-043	4	Paleontology	Theory + Practical	50	20	30	100
	GEOMJ-044	4	Principles of Stratigraphy	Theory + Practical	50	20	30	100
5th	GEOMJ-051	4	Metamorphic Petrology	Theory + Practical	50	20	30	100
	GEOMJ-052	4	Stratigraphy of India	Theory + Practical	50	20	30	100
	GEOMJ-053	4	Hydrogeology and Oceanography	Theory + Practical	50	20	30	100
	GEOMJ-054	4	Economic Geology	Theory + Practical	50	20	30	100
6th	GEOMJ-061	4	Geodynamics and Tectonics	Theory + Practical	50	20	30	100
	GEOMJ-062	4	Engineering Geology	Theory + Practical	50	20	30	100
	GEOMJ-063	4	Remote Sensing and GIS	Theory + Practical	50	20	30	100
	GEOMJ-064	4	Geomorphology	Theory + Practical	50	20	30	100
	GEOMJ-065	2	Field Work		-	35	15	50
7th	GEOMJ-071	4	Exploration and Mining Geology (4)	Theory + Practical	50	20	30	100
	GEOMJ-072	4	Fuel Geology (4)	Theory + Practical	50	20	30	100

	GEOMJ-073	4	River Science (4)	Theory + Practical	50	20	30	100
	GEOMJ-074	4	Earth Climate and Environment (4)	Theory + Practical	50	20	30	100
	GEOMJ-075	2	Research Methodology	Theory	35	-	15	50
8th	GEOMJ-071	4	Basin Analysis (4)*	Theory + Practical	50	20	30	100
	GEOMJ-072	4	Geostatistics and Data Analysis in Earth Sciences (4)	Theory + Practical	50	20	30	100
	GEOMJ-073	4	Evolution of life through time (4)*	Theory + Practical	50	20	30	100
	GEOMJ-074	4	Geology of North East India (4)	Theory + Practical	50	20	30	100
	GEOMJ-075	2	Project Work	Practical	-	35	15	50
		10	Dissertation	Practical				

Minor Course

1st	GEOMI-011	4	Fundamentals of Earth System Science I	Theory + Practical	50	20	30	100
2nd	GEOMI-021	4	Fundamentals of Earth System Science II	Theory + Practical	50	20	30	100
3rd	GEOMI-031	4	Rocks and Minerals	Theory + Practical	50	20	30	100
4th	GEOMI-041	4	Historical Geology	Theory + Practical	50	20	30	100
5th	GEOMI-051	4	Earth Resource	Theory + Practical	50	20	30	100
6th	GEOMI-061	4	Climate and Environmental Geology	Theory + Practical	50	20	30	100

Multidisciplinary Course

1st	GEOMU-011	3	Introduction to Earth Science	Theory	50		25	75
2nd	GEOMU-021	3	Introduction to Earth Science	Theory	50		25	75
3rd	GEOMU-031	3	Introduction to Earth Science	Theory	50		25	75

Skill Enhancement Course (SEC)

1st	GEOSK-011	3	Laboratory Techniques -soil, water and survey (3)	Practical		50	25	75
2nd	GEOSK-021	3	Laboratory Techniques -soil, water and survey (3)	Practical		50	25	75
3rd	GEOSK-031	3	Laboratory Techniques -soil, water and survey (3)	Practical		50	25	75

Syllabus for Geology Major and Minor Course (Same syllabus for Major and Minor Course for Semester I and II)

Semester-I

COURSE TITLE: FUNDAMENTALS OF EARTH SYSTEM SCIENCE-I
Course Code: GEOMJ-011/GEOMI-011

Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination: **70 (Theory: 50 and Practical: 20)**

In Semester Assessment: **30**

Learning Objective: *To acquire a holistic understanding of dynamics of the planet Earth, its spheres and interior.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the planet Earth as integral part of the universe, the dynamism affecting every aspect of the planet Earth including the interrelationship among atmosphere, lithosphere, and hydrosphere. The students will also learn about Earth's internal zonation, the physical and chemical characters of each zone, its magnetic field and the global geodynamic processes.*

THEORY:

Unit 1: Holistic understanding of the planet Earth **Marks: 08** **No of Classes:07**

Introduction to various branches of Earth Sciences and its relation to other branches of science. Origin of the Universe, Solar System and its planets. The terrestrial and jovian planets. Meteorites and Asteroids

Unit 2: **Earth and its Spheres** **Marks: 13** **No of Classes:10**
Earth in the solar system - size, shape, mass, density, rotational and revolution parameters, and its age.
Geosphere (Atmosphere, Hydrosphere, Cryosphere, Lithosphere): Origin and composition,
Biosphere: Components
Pedosphere: Soil and soil profile

Unit 3: Interior of the earth **Marks: 10** **No of Classes: 08**
Understanding the mechanical layering of the Earth through seismic waves.
Formation and elemental composition of crust, mantle, and core
Geomagnetism: Causes of Earth's magnetism, Earth's magnetic field- changes and effects

Unit 4: Geodynamics **Marks: 13** **No of Classes: 12**
Heat-flow pattern in the Earth

Concept of plate tectonics, sea-floor spreading, continental drift and isostasy.
Geodynamic elements of Earth- mid oceanic ridges, trenches, transform faults and island arcs
Origin of ocean basins, continents, mountains, and rift valleys
Earthquake and earthquake belts
Volcanoes- types, products, and their distribution.
Introduction to Neotectonics and Landforms

Unit 5: Understanding the past from stratigraphic records

Marks: 06 **No of Classes:08**

Nature of stratigraphic records
The concept of time in geological studies. Geologic Time and Standard Geological time scale.
Uniformitarianism, catastrophism and neptunism

PRACTICALS: **Marks: 20** **No of Classes: 15**

Identification of topographic features with the help of physiographic models.
Study of topographic maps and physiographic description of an area Identification of soil types.
Identification of horizons of soil profile.
Plotting of earthquake and volcanic belt on world map.
Preparation of Heat flow pattern.

SUGGESTED READINGS:

1. Jacobson, Michael C; Charlson, Robert J.; Rodhe, Henning; Orians, Gordon H. (Eds) (2000): Earth System Science from Biogeochemical Cycles to Global Change, Elsevier Academic Press.
2. Skinner, Brian J. and Porter, Stephen C. (1995): The Blue Planet, An Introduction to Earth System Science, John Wiley & Sons, Inc.
3. Condie, Kent C. (1976): Plate Tectonics and Crustal Evolution, ButterworthHeinemann.
4. Frisch, Wolfgang; Meschede, Martin; Blakey, Ronald (2011): Plate Tectonics Continental Drift and Mountain Building, Springer, Berlin.
5. Neser, Laura (2023): Introduction to Earth Science, Virginia Tech University
6. Kolay, A.K. (2021): Soil Geology, Atlantic Publishers & Distributors Pvt. Ltd
7. Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor& Francis.
8. Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.
9. Gross, M. G. (1977). Oceanography: A view of the earth.

Semester-II

COURSE TITLE: FUNDAMENTALS OF EARTH SYSTEM SCIENCE-II
Course Code: GEOMJ-021/GEOMI-021

Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45 + P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To gain knowledge on the fundamental concepts of geochemistry, mineralogy, petrology, structural geology, plate tectonics, and paleontology.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of distribution and abundance of earth elements and basic concept of minerals and rocks. Students will also have basic idea about geological structures. Students will also learn about fossil records.*

Unit 1: Introduction to Geochemistry **Marks: 08** **No of Classes:08**
Cosmic and terrestrial abundance of elements.
Basic geochemical environment, mobility of elements and association of elements Geochemical cycle and Residence time.
Radiogenic isotopes.

Unit 2: Introduction to Mineralogy **Marks: 10** **No of Classes:10**
Minerals-Definitions, Physical properties of minerals
Chemical bonding in minerals, Silicate structures
Nature of light and principles of optical mineralogy

Unit 3: Introduction to Petrology **Marks: 13** **No of Classes:15**
Rocks- Definitions and types, Basics of rock formation and rock cycle
Magma and lava. Extrusive and intrusive igneous rock
Formation of sediment and sedimentary rocks
Metamorphism of rocks

Unit 4: Basics of Structural Geology **Marks: 13** **No of Classes:07**
Deformation of Rocks, concept of Stress and Strain Concept
of planar and linear structures features.
Dip, strike, plunge
Common geological structures: Fold, Fault, Joints

Unit 5: Introduction to Paleontology **Marks: 06** **No of Classes:05**
Definition, branches, scope, and application of paleontology
Modes of preservation of fossils
Condition for fossilization

PRACTICALS: **Marks: 20** **No of Classes: 15**

Preparation of geochemical contour map
Study of physical properties of minerals in hand specimen
Differentiating igneous, sedimentary and metamorphic rocks in hand specimens
Use of clinometer, determination of strike, dip, plunge, rake, and pitch
Identification of mode of preservation of fossils.

SUGGESTED READINGS:

1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
5. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
6. Rollinson, H. (2007) Using geochemical data – evaluation, presentation, and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
7. Walther, J. V. (2009). Essentials of geochemistry. Jones& Bartlett Publishers.
8. Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
9. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
10. Shukla, A. C., &Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
11. Neser, Laura (2023): Introduction to Earth Science, Virginia Tech University
12. Misra, Kula C (2016): Introduction to Geochemistry Principles And Applications, Wiley India

Syllabus for Multidisciplinary Course Same syllabus will be followed in Semester I, II and III

COURSE TITLE: INTRODUCTION TO EARTH SCIENCE
Course Code: GEOMU– 011/021/031
Credits: 03(only Theory) **No. of Classes: 45**

Marks: Total: 75 (End Semester: 50 and Internal Assessment: 25)

Learning Objective: *To give a fundamental understanding of the processes involved in the planet earth and common natural resources.*

Learning Outcome: *At the end of the course the student will have basic knowledge and understanding on earth system, its dynamics, and resources.*

Unit 1: Earth as a Planet **Marks:10** **No of Classes:10**

Origin of the Universe, Solar System, and its planets
Earth in the solar system - size, shape, mass, density, rotational and revolution parameters, and its age.
Introduction to Geosphere

Unit 2: Minerals and Rocks **Marks:10** **No of Classes:7**

Minerals-Definition, important physical properties, important rock forming minerals. Rocks – Definition and types. Commonly occurred rocks and their uses

Unit 3: Soil and Water **Marks:10** **No of Classes:8**

Definition of soil, soil profile. Soil types of India. Soil erosion
Water- Surface and ground water, their use and management

Unit 4: Geohazards **Marks: 10** **No of Classes:10**

Dynamic Earth Process- Plate Tectonics Hazards,
Risks & Disasters.
Geo Hazards: Causes, effect and mitigation of earthquake, landslide,flood and bank erosion, Urban Floods
Disaster Management.

Unit 5: Earth Resources **Marks: 10** **No of Classes:10**

Occurrence and types of Coal
Occurrence of Petroleum
Economic minerals and their uses. Important economic minerals of India
Geothermal energy

SUGGESTED READINGS:

1. Mukerjee, P. K. (2013): A Textbook of Geology, World Press,
2. Mahapatra, G. B (2019): A Textbook of Geology, CBS Publishers & Distributors
3. Mahapatra, G. B (2018): A Textbook of Physical Geology, CBS Publishers & Distributors
4. Bangar, K. M (2021): Principals of Engineering Geology, Standard Publishers Distributors, New Delhi
5. Bangar, K. M (2019): General and Engineering Geology, Standard Publishers Distributors, New Delhi
6. Prasad, Umeshwar (2019): Economic Geology: Economic Mineral Deposit, CBS Publishers & Distributors.
7. Lutgens, Frederick K. and Tarbuck, Edward J. (2012): **Essentials of Geology,** Prentice Hall

Syllabus for Skill Enhancement Course (SEC) Same syllabus will be followed in Semester I, II and III

COURSE TITLE: LABORATORY TECHNIQUES: SOIL, WATER AND SURVEY
Course Code: GEOSK-011/021/031
Credits: 03 (only Practical) **No. of Classes: 45**

Total Marks: 75 (End Semester: 50 and Internal Assessment: 25)

Learning Objective: *To develop important surveying skills and identify soil and water qualities.*
Learning Outcome: *At the end of the course the student will know the basic properties of soil and water and learn how to find the qualities of soil and water. Students also learn simple methods of measurement of length, area, and height on the earth surface.*

Unit 1: Basics of land surveying **Marks: 25** **Class:20**
Land surveying tools
Map reading, Topographic maps and satellite imageries
Contouring, Digitization of the map data
Use of compass and determination of bearing
Length and height measurement – actual value and approximation
Pacing and height approximation in the field
Location of field point on the map and map point in the field

Unit 1: Basics of Soil and Water Testing **Marks: 25** **Class: 25**

Sampling and Bathymetry
Engineering properties of soil,
Different tools used for analysis of soil
Determination of soil properties
Classification of soil based on identified properties
Soil profile study

Occurrence of surface and ground water
Physical, chemical, and dynamic properties of surface and groundwater
Evaluation of water quality
Water testing tools and methods
Water table contouring and determination of flow-lines

SUGGESTED READINGS:

1. Meyers, Robert A (2001): Encyclopedia of Physical Science and Technology, measurements techniques and instrumentation, Elsevier Science Ltd.
2. Barnes, John W. and Lisle, Richard J. (2004): Basic Geological Mapping, John Wiley & Sons Ltd, West Sussex, England.
3. Khambalkar, Priyadarshani A; Yadav, Shashi S; Singh, Akhilesh; Trivedi, S K & Narendra Gurjar, S (2022): Practical Manual on Soil Testing, I B P S S Publication. 4. Maharaj, Dr. D.K. (2017):aboratory Manual For Soil Testing, S.K. Kataria & Sons
5. Singh, P (2017): Practical Manual Of Water Analysis, Agri Biovet Press.
6. Khanna, D. R and Bhutani, R (20211): Laboratory Manual of Water and Wasteland Analysis, Daya Publishing House, New Delhi.
7. Moorberg, Colby. J. AND Crouse, David. A.(2021): Soils Laboratory Manual, New Prairie Press, Manhattan.
8. Singh, Ummed and Praharaj, C S (2017): Practical Manual, Chemical Analysis of Soil and Plant Samples, ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh (India)-208 024

Syllabus for Geology Major Course

Semester-III

COURSE TITLE: MINERAL SCIENCE

Course Code: GEOMJ-031
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding of minerals and its properties.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the morphology and internal structure of different crystal system and groups.*

The students will also learn about physical chemical and optical properties of rock forming minerals.

THEORY:

Unit 1: Crystallography **Marks: 08** **No of Classes:06**

Elementary ideas about crystal morphology - faces, edges and solid angle; Interfacial angle and its measurement
Crystal symmetry and classification of crystals into six systems and 32-point groups Crystal parameters and indices

Unit 2: Crystal Chemistry **Marks: 10** **No of Classes:09**
Elements of crystal chemistry: Unit cell; Definition and types of lattices; Significance of the lattice; Bravais (Space) lattices. Introduction to nanostructures
Crystal growth and twinning; Types of Twinning, Origin of twinning, Twin laws, Twin laws of minerals in different crystal systems

Unit 3: Crystal Projection **Marks: 06** **No of Classes:06**
Concept of spherical and stereographic projection
Stereographic projections of symmetry elements and forms

Unit 4: Optical Mineralogy: **Marks: 13** **No of Classes: 12**
Isotropic and Anisotropic minerals; Optic axis; Optical Indicatrix
Introduction to the petrological microscope Properties
of minerals in thin section
Uniaxial and Biaxial Interference figures, determination of optic sign

Unit 5: Rock-forming Minerals **Marks: 13** **No of Classes: 12**
Physical and optical properties, atomic structure and chemistry of the following groups of minerals – Olivine, Garnet, Pyroxene, Amphibole, Mica, Clay minerals, Silica, Feldspar and Feldspathoid.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Study of the forms, symmetry elements and Stereographic projection of crystals belonging to the Normal classes of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic & Triclinic systems
Study of twinning with the help of crystal models with reference to composition plane, twin plane and twin axis.
Study & Identification of common rock-forming minerals in thin section under Petrological Microscope
Study under Petrological Microscope of uniaxial and biaxial interference figures and their recognition.
Determination of the composition of plagioclase by Michael-Levy method

SUGGESTED READINGS:

1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy.McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., &Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.

COURSE TITLE: STRUCTURAL GEOLOGY
Course Code: GEOMJ-032
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20)**
In Semester Assessment: **30**

Learning Objective: *To acquire a understanding of different geological structures.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the topography, mechanics of related to formation, and classification of different types of geological structure.*

THEORY:

Unit 1: Structure and Topography **Marks: 08** **No of Classes:07**
Topographic and structural maps; Important representative factors of the map, Effect of topography on outcrop pattern structural features.

Unit 2: **Stress and strain in rocks** **Marks: 10** **No of Classes:08**
Concept of rock deformation: Stress and Strain in rocks, Strain ellipses of different types and their geological significance. Mohr circle
Planar and linear structures; Concept of dip and strike; pitch and plunge

Unit 3: Folds **Marks: 13** **No of Classes: 10**
Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding

Unit 4: Foliation and lineation **Marks: 13** **No of Classes: 10**
Description and origin of foliations: axial plane cleavage and its tectonic significance Description and origin of lineation and relationship with the major structures

Unit 5: Fractures, faults and shear zone **Marks: 06** **No of Classes: 10**

Geometric and genetic classification of fractures and faults
Effects of faulting on the outcrops
Shear Zones and types
Geologic/geomorphic criteria for recognition of faults and fault plane solutions Fracture array analysis

PRACTICALS: **Marks: 20** **No of Classes: 15**

Basic idea of topographic contours, Topographic sheets of various scales.
Introduction to Geological maps: Lithological and Structural maps
Structural contouring and 3-point problems of dip and strike
Drawing profile sections and interpretation of geological maps of different complexities
Exercises of stereographic projections of mesoscopic structural data (planar and linear)

SUGGESTED READINGS:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology.Chapman& Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill
7. Fossen, H. (2016) Structural Geology, Cambridge University Press
8. Ghosh, S. K. (1993) Structural Geology: Fundamentals and Modern Developments, Elsevier Science & Technology Books
9. Twiss, R. J. and Moores E. M., (2007) Structural Geology, W. H. Freeman

COURSE TITLE: ELEMENTS OF GEOCHEMISTRY
Course Code: GEOMJ-033
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding of the geochemical environment of solid earth and solar materials.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the geochemical characteristics of different layers of the Earth. The students will also learn about geochemical behaviour of major elements, trace element, REE as well* as geochemistry of solid earth, solar materials and magmatic products.

THEORY:

Unit 1: Concepts of geochemistry **Marks: 08** **No of Classes:07**
Importance and applications in Geology,
Introduction to properties of elements: Atomic Structure, Periodic table, Chemical bonding, states of matter and atomic environment of elements Geochemical classification of elements, Geochemical cycle

Unit 2: **Mass conservation and elemental fractionation Marks: 08** **No of Classes:08**
Nuclides and radioactivity
Conservation of mass, isotopic and elemental fractionation
Concept of radiogenic isotopes in geochronology and isotopic tracers, Principle and methodology of isotope dating

Unit 3: Element transport **Marks: 10** **No of Classes: 10**
Advection and diffusion
Chromatography
Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations
Concept of marine chemistry
Environmental Geochemistry: Anthropogenic influences on geochemical cycles (Carbon Cycle, Nitrogen Cycle, water cycle etc.)

Unit 4: Geochemistry of solid Earth **Marks: 12** **No of Classes: 10**
The Earth in the solar system, the formation of solar system
The Solid Earth – geochemical variability of magma and its products; Composition of crust, mantle and core of the Earth;
Composition of the bulk silicate Earth
Composition of meteorites and lunar rocks

Unit 5: Application of Geochemistry (Applied Geochemistry) Marks: 12No of Classes: 10 Geochemical Tools and Techniques; Analytical methods (e.g., XRF, ICP-MS);
Utility of major, trace and rare earth elements in Igneous, Sedimentary and Metamorphic rocks;
Chemical analysis of rocks and minerals;
Geochemical signatures of mineral deposits;
Exploration and utilization of geothermal resources;
Geochemical behavior of important Major, Trace and Rare Earth Elements.

PRACTICALS: **Marks: 20**

Geological Field Work (Viva + Field Report)

SUGGESTED READINGS:

1. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.10
2. Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition.Publisher Longman Scientific & Technical.
3. Walther, J. V. (2009). Essentials of geochemistry.Jones & Bartlett Publishers.
4. Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
5. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications, Wiley India Pvt. Ltd
6. Coe, A. L. (2010) Geological Field Techniques, Wiley Blackwell
7. Compton, R. R. (1962) Manual of Field Geology, John Wiley & Sons Inc

Syllabus for Geology Minor Course

Semester-III

COURSE TITLE: ROCKS AND MINERALS
Course Code: GEOMI-031
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding of minerals, their properties and different types of rocks.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding on physical, chemical and optical properties of rock forming minerals. They will also have an understanding on different rock types, their process of formation and classifications.*

THEORY:

Unit 1: Optical Mineralogy: **Marks: 10** **No of Classes: 09**

Isotropic and Anisotropic minerals; Optic axis; Optical Indicatrix
Introduction to the petrological microscope
Properties of minerals in thin section

Unit 2: Rock-forming Minerals **Marks: 10** **No of Classes: 09**

Physical and optical properties, atomic structure and chemistry of the following groups of minerals – Olivine, Garnet, Pyroxene, Amphibole, Mica, Silica, Feldspar

Unit 3: Igneous Petrology **Marks: 10** **No of Classes: 09**

Generation, composition and nature of magmas and lavas.
Concept of nucleation, crystal growth and texture
Modes of occurrence of Igneous rocks Textures
and structures of Igneous rocks.
Classification of igneous rocks: Textural, Chemical (CIPW) and Mineralogical (IUGS)

Unit 4: Sedimentary Petrology **Marks: 10** **No of Classes: 09**
Concept of Source-Transport-Sink.
Weathering and diagenesis of sediments
Grain size scale, particle shape and fabric
Sedimentary structure- Primary and syn-sedimentary structures
Sedimentary rock types- clastic, chemical and biochemical rocks

Unit 5: Metamorphic Petrology **Marks: 10** **No of Classes: 09**
Metamorphism: Definition, controls and types. Factors controlling metamorphism.
Metasomatism and role of fluids in metamorphism
Metamorphic facies and grades, Index minerals
Metamorphic mineral reactions (prograde and retrograde).
Metamorphic rock- Slate, Phyllite, Schist, Gneisses, Hornfels.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Study of physical properties of minerals
Introduction to optical microscopy
Study of optical properties of minerals
Study of physical properties of rocks
Study of optical properties of rock under thin sections
Understanding crystal symmetry via wodden models
Stereographic projection of mineral faces

SUGGESTED READINGS:
I. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.
2. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and company, New York.

Semester-IV

COURSE TITLE: IGNEOUS PETROLOGY
Course Code: GEOMJ-041
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20)**
In Semester Assessment: **30**

Learning Objective: *To acquire an understanding of composition of magma and petrogenesis of igneous rock.*

7 ***Learning Outcome:*** *At the end of the course the student will have knowledge and understanding of the genesis, nature, composition, form, thermal and chemical properties of magma. The students will also learn about the magmatism in different tectonic settings and petrogenesis of major igneous rock types.*

THEORY:

Unit 1: Concept of Magma Generation **Marks: 08** **No of Classes:07**
Heat flow, geothermal gradients through time, composition and nature of magmas and lavas. Concept of nucleation, crystal growth and texture; Generation of magmas. Role of partial melting in igneous petrogenesis.

Unit 2: **Textures, Structures and Classification** **Marks: 10** **No of Classes:08**
Modes of occurrence of Igneous rocks
Textures and structures of Igneous rocks. Petrogenesis and texture
Classification of igneous rocks: Textural, Chemical (CIPW) and Mineralogical (IUGS)
Suit Classification of igneous rocks

Unit 3: Phase diagrams and petrogenesis **Marks: 13** **No of Classes: 10**
Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic Magmas. Reaction principles and the crystallization of magmas. Evolution of magmas. Primary and derivative magmas;
Role of voletiles in magma. Concept of conganuity and variation diagrams.

Unit 4: Magmatism and tectonic settings **Marks: 13** **No of Classes: 10**
Magmatism in oceanic domains (MORB, OIB) Magmatism along plate margins (Island arcs/continental arcs). Magmatism in Intraplate domains. Geochemical criteria for identification of paleotectonic settings

Unit 5: Petrogenesis of Igneous rocks **Marks: 06** **No of Classes: 10**
Petrogenesis of common Granitic, Basic, Alkaline and Ultramafic Rocks Kimberlites, Charnockites, Carbonatite, Lamprophyre, Komatiites.

PRACTICALS: **Marks: 20** **No of Classes: 15**
Microscopic study of mineralogical and textural characteristics of igneous rocks

CIPW Norm calculation

SUGGESTED READINGS:

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
6. Myron G. Best (2001). Igneous and Metamorphic Petrology,
7. K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
8. Bose M.K. (1997). Igneous Petrology.
9. G W Tyrrell. (1926). Principles of Petrology. Springer

COURSE TITLE: SEDIMENTARY PETROLOGY
Course Code: GEOMJ-042
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire a understanding of processes of formation structure and textures of sedimentary rock and their application in study of geological history.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the processes of formation of sediment and sedimentary rocks, its structures, and textures. The students will also learn about the different types of sedimentary rocks and their application in study of geological history.*

THEORY:

Unit 1: Origin of sediments **Marks: 08** **No of Classes:07**
Concept of Source-Transport-Sink.
Weathering and sediment flux: Types and processes of weathering
Types of fluids, Laminar vs. turbulent flow Particle entrainment, transport and deposition.

Unit 2: **Sedimentary Texture** **Marks: 10** **No of Classes:08**
Grain size scale, particle size distribution and statistical analysis; particle shape and fabric

Unit 3: Structures and Environment **Marks: 13** **No of Classes: 12**

Sedimentary structure- Primary and syn-sedimentary structures, Bouma sequence
Paleocurrent analysis,
Provenance and Heavy minerals.
Tectonic control on Sedimentation
Facies, Depositional environment and reconstruction

Unit 4: Varieties of sedimentary rocks **Marks: 13** **No of Classes: 12**

Siliciclastic rocks and their classification: Conglomerates, sandstones, mudrocks.
Carbonate rocks: controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation.

Unit 5: Diagenesis **Marks: 06** **No of Classes: 06**

Concepts of diagenesis, Stages of diagenesis, Compaction, Cementation, lithification and authigenesis.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Study of sedimentary rocks in thin sections,
Study of texture in thin sections and hand specimens,
General overview on depositional conditions and provenance from the study of framework, cement and matrix of given sedimentary rock in thin section.

SUGGESTED READINGS:

1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimenary Petrology, Blackwell Publishing.
3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
4. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell
5. Boggs, Jr. S, Boggs S, (2013) Principles of Sedimentology and Stratigraphy. Pearson Education
6. Boggs S. (2009), Petrology of Sedimentary Rocks. Cambridge University Press

COURSE TITLE: PALEONTOLOGY
Course Code: GEOMJ-043
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding of different processes of fossilization and characteristics of some major invertebrate, vertebrate and plant fossil forms.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the processes of formation of fossilization and evolutionary theories and taxonomy of organisms. The students will also learn about the morphology, biostratigraphic significance and functional adaptation of some major invertebrate, vertebrate and plant fossil forms as well as its academic, environmental and industrial applications.*

THEORY:

Unit 1: Introduction **Marks: 06** **No of Classes: 07**
Application of palaeontology. Cambrian Explosion and mass extinctions, Sepkoski's Evolutionary Faunas, Advent of oxygen, plastids, and plankton, Taphonomy and the utility of fossil preservation.

Unit 2: **Taxonomy and Species concept** **Marks: 10** **No of Classes: 08**
Taxonomy and Species concept, Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record and palaeontological evidences for organic evolution. Coevolution. Climate and Evolution

Unit 3: Invertebrates **Marks: 13** **No of Classes: 10**
Invertebrates, Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda, Foraminifera) and their biostratigraphic significance, Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications, Functional adaptation in trilobites and ammonoids.

Unit 4: Vertebrates **Marks: 13** **No of Classes: 10**
Vertebrates, Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs, Evolution of horse and elephant, Intercontinental migration of horse. Human evolution. .

Unit 5: Application of fossils **Marks: 08** **No of Classes: 10**
Introduction to Paleobotany, Gondwana Flora, Introduction to Ichnology. Application of fossils in Stratigraphy, Biozones, index fossils, correlation, Role of fossils in sequence stratigraphy; Fossils and paleoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers; Paleoecology – fossils as a window to the evolution of ecosystems.

PRACTICALS: **Marks: 20** **No of Classes: 15**
Study of fossils showing various modes of preservation;
Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils

SUGGESTED READINGS

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Shukla, A. C., &Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher

5. Armstrong, H. A., &Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

COURSE TITLE: PRINCIPLES OF STRATIGRAPHY

Course Code: GEOMJ-044
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**
Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20) In**
Semester Assessment: **30**

Learning Objective: *To acquire an understanding on the principles, types and analytical methods of stratigraphy.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding laws of stratigraphy and nomenclature of diffenent stratigraphic units. The students will also learn about the dynamic aspect of stratigraphy and the methods to date a stratigraphic units*

THEORY:

Unit 1: Introduction **Marks: 06** **No of Classes: 05**
Principles of stratigraphy, Geological Time scale, Crustal and biological evolution of earth through geologic time.

Unit 2: Code of stratigraphic nomenclature **Marks: 12** **No of Classes: 11**
Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).

Unit 3: Principles of stratigraphic analysis Marks: 10 No of Classes: 09 Stratigraphic contacts and unconformities, Types of unconformities. Facies concept in stratigraphy. Walther's Law of Facies. Principles of stratigraphic correlation. Concept of paleogeographic reconstruction.

Unit 4: Dynamic Stratigraphy **Marks: 12** **No of Classes: 11**
Introduction to dynamic Stratigraphy; Seismic stratigraphy - Methods and application;
Chemostratigraphy – Method and Applications of Oxygen Isotopes; Carbon Isotopes; Strontium Isotopes and Sulphur Isotopes; Magnetostratigraphy – Field reversal, polarity time scale and magnetostratigraphic correlation; Sequence stratigraphy – Accommodation space, transgression and regression and sequence stratigraphic units.

Unit 5: Geochronological methods in Stratigraphy Marks: 10 No of Classes: 09 Relative dating methods: Superposition of strata, original horizontality, faunal succession, cross-cutting relationship

Absolute dating methods: Radiometric dating methods: U-Th-Pb, K-Ar, Sm- Nb and ^{14}C dating methods; Introduction to thermochronology; Luminescence dating; dendrochronology and varve chronology

PRACTICALS: **Marks: 20** **No of Classes: 15**

1. Identification of unconformities through models/block diagram
2. Study of lithological contacts and their relationship in map
3. Stratigraphic correlation of strata

SUGGESTED READINGS:

7. Boggs, Jr. S, Boggs S, (2013) Principles of Sedimentology and Stratigraphy. Pearson Education

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Syllabus for Geology Minor Course

Semester-IV

COURSE TITLE: Historical Geology
Course Code: GEOMI-041
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding on the crustal and biological evolution of the earth and the stratigraply of india.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the crustal and biological evolution of the earth. The students will also learn about different principles of stratigraphy and the stratigraphic records of India.*

THEORY:

Unit 1: Introduction **Marks: 07** **No of Classes: 07**

Introduction to Historical Geology, Super continent cycle, Faults, Folds, Mountains, Sculpting Landscapes/Slopes, Deformation**.** Early Earth: Hadean and Archean Eons, Proterozoic Eon, Fossils and Life on Earth, Sedimentary Archives, Events and Extinction,

Unit 2: **Marks: 08** **No of Classes: 07**

Taxonomy and Species concept, Species concept with special reference to paleontology, Invertebrates, Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance, Vertebrates, Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs Evolution of horse and intercontinental migrations. Human evolution

Unit 3: **Marks: 08** **No of Classes: 07**

The geologic time scale Fundamental Geologic Principles, Principles of stratigraphy, Fundamentals of litho-, bio- and chrono-stratigraphy, Code of stratigraphic nomenclature, International Stratigraphic Code – development of a standardized stratigraphic nomenclature.
Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy. Physiographic and tectonic subdivisions of India,

Unit 5: **Marks: 14** **No of Classes: 07**

Introduction to Indian Shield. Geology of Dharwar and Singhbhum Craton. Introduction to Proterozoic basins of India. Geology of Vindhyan and Cudappah basins of India. Phanerozoic Stratigraphy of India. Paleozoic Succession of Kashmir andSpiti Stratigraphy.Gondwana basins.
Mesozoic stratigraphy of India: a. Triassic successions of Spiti, b. Jurassic of Kutch, c. Cretaceous, successions of Cauvery basins, Cenozoic stratigraphy of India: a. Kutch basin, b. Siwalik successions, c. Assam and Arakan basins.

PRACTICALS: **Marks: 20** **No of Classes: 15**

FIELD WORK **Marks: Total 20 (Field Report 15 and Internal Assessment: 05)**

1. Study of geological map of India and identification of major stratigraphic units.
2. Study of rocks in hand specimens from known Indian stratigraphic horizons
3. Drawing various paleogeographic maps of Precambrian time 4. Study of different Proterozoic supercontinent reconstructions.

SUGGESTED READINGS:

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Syllabus for Geology Major Course

Semester-V

COURSE TITLE: METAMORPHIC PETROLOGY

Course Code: GEOMJ-051
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20) In**
Semester Assessment: **30**

Learning Objective: *To acquire a understanding of processes of metamorphism.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the processes of metamorphism and their types. The students will also learn about the facies and grade concept in metamorphism and different metamorphic reactions.*

Learning Objective:

Learning Outcome:

THEORY:

Unit 1: Introduction **Marks: 08** **No of Classes:07**
Metamorphism: Definition, controls and types.. Factors controlling metamorphism. Some special types of metamorphism - Contact, Regional, Fault zone and impact metamorphism. Classification of metamorphic rocks. Types of Protoliths, Metasomatism and role of fluids in metamorphism

Unit 2: **Marks: 10** **No of Classes:12**
Mineralogical phase rule of closed and open system, Structure and textures of metamorphic rocks, General idea about the thermodynamic consideration in metamorphic rock, Equilibrium in metamorphism. The phase rule and its application in metamorphic rocks, Common chemographic diagrams-ACF and AKF diagrams.

Unit 3: **Marks: 13** **No of Classes: 08**
Metamorphic facies and grades, Index minerals, Metamorphic zones and isograde. Concept of metamorphic facies and grade. Metamorphism and Tectonism, Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde). Regional metamorphism of argillaceous, calcareous and basic rocks

Unit 4: **Marks: 13** **No of Classes: 08**

Metamorphic reactions and its types: Polymorphic transformation, exsolution reactions, Solid - solid net transfer reactions, devolatilization reactions, Continuous reactions, oxidation/reduction reactions. Univarient and bivarient reaction and their significance. An introduction to geothermobarometry: Geothermobarometry, Geothermometers and geobarometers.

Unit 5: **Marks: 06** **No of Classes: 10**

Metamorphic rock associations- Schists, Gneisses, Khondalites, Blue Schists, Eclogites, Slate, Phyllite, Schist, Quartzite, Marble, Amphibolite, Granulite, Hornfels and Migmatites.

PRACTICALS: **Marks: 20** **No of Classes: 15**

1. Study of metamorphic rocks in hand specimens,
2. Study of metamorphic rocks in thin sections,
3. Study of texture in thin section and hand specimens,
4. Study of metamorphic phase diagrams

SUGGESTED READINGS

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology.Cambridge University Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation.Routledge.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGrawHill Science Engineering.
5. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology.Longman Earth Science Series.

COURSE TITLE: STRATIGRAPHY OF INDIA
Course Code: GEOMJ-061
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire a understanding on the stratigraphic records in India.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding on the stratigraphic records of the Indian subcontinent from precambian to recent. The students will also learn about the volcanic provinces in India and will be introduced to the quaternary records in India.*

THEORY:

Unit 1: Introduction **Marks: 06** **No of Classes: 05**
Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield – cratons, mobile belts and Proterozoic basins. A brief outline of the geology of India – Precambrian to Recent.

Unit 2: Precambrian Stratigraphy of India Marks: 15 No of Classes: 14 Geologic evolution with emphasis on sedimentation, lithology, magmatism, structure, metamorphism, geochronology and economic importance of: a) Singhbhum Craton, b) Dharwar Craton, c) Bastar Craton, d) Aravalli craton e) Assam-Meghalaya Plateau; f) Central Indian Tectonic Zone, g) Chhotanagpur Granite Gneiss Belt, h) Eastern Ghats Belt, i) Southern Granulite Terrane; j) Vindhyan basin and k) Cudappah basins

Unit 3: Phanerozoic Stratigraphy of India **Marks: 17** **No of Classes:16**
Paleozoic Succession of Kashmir and its correlatives from Spiti and Zanskar Stratigraphy.
Structure Lithology and hydrocarbon potential of Gondwana basins.
Mesozoic stratigraphy of India:
a. Triassic successions of Spiti, b. Jurassic of Kutch, c. Cretaceous, successions of Cauvery basins
Cenozoic stratigraphy of India:
a. Kutch basin, b. Siwaliks, c. Assam, Andaman and Arakan basins.

Important stratigraphic boundaries during Phanerozoic time in India - a. PrecambrianCambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary.

Unit 4: Volcanic provinces of India **Marks: 06** **No of Classes: 05**
a) Panjal Volcanics b) Deccan, c) Rajmahal, d) Sylhet Trap e) Abor Volcanics

Unit 5: Quaternary Geology **Marks: 06** **No of Classes: 05**
Subdivisions of Quaternary Geology of India: criteria and units; Major paleoclimatic and paleo-geographic events in Quaternary period with special emphasis on the Indian Subcontinent; Quaternary successions in India.

PRACTICALS: **Marks: 20** **No of Classes: 15**
Mapping of major stratigraphic units from India.
Study of rock in hand specimens from known Indian stratigraphic horizon Preparation of stratigraphic column

SUGGESTED READINGS:

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
3. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

COURSE TITLE: HYDROGEOLOGY
Course Code: GEOMJ-053
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding of different hydrogeologic aspects.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the fundamental concepts of hydrogeology, laws and principles of groundwater dynamics. The students will also learn about well hydraulics, groundwater exploration and management.*

THEORY:

Unit 1: INTRODUCTION AND BASIC CONCEPTS Marks: 10 No of Classes:07
Scope of hydrogeology and its societal relevance.
Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Concept of hydrograph
Origin of groundwater, Rock properties affecting groundwater, Vertical distribution of subsurface water.
Genetic classification of groundwater.

Unit 2: Aquifer and Aquifer parameters Marks: 10 No of Classes:07
Types of aquifers: unconfined, confined and semi-confined, Perched aquifer
Water table and piezometric surface.,
Aquifer parameters; anisotropy and heterogeneity of aquifers.

Unit 2: Flow Dynamics Marks: 10 No of Classes:07
Basic principles of groundwater flow. Darcy's law and its validity. Intrinsic permeability and hydraulic Conductivity. Groundwater flow rates and flow direction. Laminar and turbulent groundwater flow.

Unit 3: GROUNDWATER EXPLORATION Marks: 10 No of Classes:07
Surface-based groundwater exploration methods Introduction to subsurface borehole logging methods. Basic Concepts of drawdown; specific capacity etc. Equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers. Theory of groundwater flow, Introduction to Well Hydraulics.

Unit 4: Groundwater Development & Management Marks: 10 No of Classes:07 Concept of groundwater management. Surface and subsurface water interaction. Groundwater level fluctuations. Basic concepts of water balance studies, issues related to groundwater resources

development and management (Principles of sustainable groundwater development and management). Rainwater harvesting and artificial recharge of groundwater.

Unit 5: Groundwater Pollution and Contamination Marks: 10 No of Classes:07

Groundwater quality, Standards, Concept of Groundwater Pollution and Contamination, Source and types of contamination, groundwater pollution: arsenic, fluoride and nitrate, sea water intrusion in coastal aquifers and their remedial measures. Case studies on arsenic pollution of Gangetic- Brahmaputra plains

Groundwater provinces in India, Aquifer systems around the world

PRACTICALS: Marks: 20 No of Classes: 15

Preparation and interpretation of water level contour maps and depth to water level maps

Study, preparation and analysis of hydrographs for differing groundwater conditions Water potential zones of India (map study).

Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams)

Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

SUGGESTED READINGS:

1. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
3. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. L
4. Hiscock, K. M. and Bense, V. F. (2015) Hydrogeology: Principles and Practice, Wiley Blackwell
5. McPherson, T. (2022) Hydrogeology: Principles and Applications, Syrawood Publication House

COURSE TITLE: ECONOMIC GEOLOGY

Course Code: GEOMJ-054

Credits: 04 (Theory- 03 + Practical- 01) No. of Classes: 75 (T-45+ P-30)

Marks: Total 100

End Semester Examination: 70 (Theory: 50 and Practical: 20)

In Semester Assessment: 30

Learning Objective: *To acquire a understanding on the process and controls of ore formation and ore deposits in India.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the classification and processes of ore formation, their textures and structures. The students will also learn about the role of plate tectonics in ore formation and ore deposits in India.*

THEORY:

Unit 1: Introduction **Marks: 08** **No of Classes:07**

Ores, gangue minerals, tenor, grade, Resources and reserves

Mineral deposits, Mineral occurrence, Mineral deposit and Ore deposit, Historical concepts of ore genesis: Man's earliest vocation- Mining, classification schemes of mineral deposits: UNFC, JORC; MMDR, NMET, DMF

Unit 2: Ore Forming Processes **Marks: 12** **No of Classes:11**

Endogenous processes: Magmatic concentration, pegmatitic deposits, porphyry deposits, skarns, and hydrothermal deposits: VMS, VHMS, SEDEX,

Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit 3: Structure, texture and geochemistry of ore deposits

Marks: 10 **No of Classes: 09**

Morphology of Ore deposits, Concordant and discordant ore bodies Texture of ore deposits

Stability, Transport and precipitation of metals from hydrothermal fluids, Wall rock alteration, Fluid inclusion and stable isotope in ore geochemistry

Unit 4: Plate tectonics and Metallogeny **Marks: 10** **No of Classes:09**

Role of plate tectonics in mineral deposits

Controls of ore localization

Metallogenic provinces and epochs

Important metallogenic provinces in the world: Bushveld complex, Witwatersrand basin, Sudbury complex

Unit 5: Indian Ore Deposits **Marks: 10** **No of Classes:09**

Important metallic deposits of India: **Iron**: Iron ores in Singhbhum-Odisha, Karnataka-Andhra Pradesh, Chhattisgarh; **Manganese:** Gonditic Mn ores, Mn nodules; **Chromite:** Chromite deposits in Odisha and Karnataka, Nagaland-Manipur **Gold:** Greenstone-hosted Au; **Copper:** Singhbhum Cu–U deposits, Malanjkhand Cu; **Lead-Zinc:** Sediment-hosted Pb–Zn sulphide ores of Rajasthan; **Aluminum:** East coast bauxites, Aluminium deposits of Gujarat-Rajasthan Atomic and strategic mineral deposits of India.

Non-metallic and industrial rocks and minerals in India. Introduction to gemstones.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Megascopic identification

Study of microscopic properties of ore forming minerals (Oxides and sulphides)20

Preparation of maps: Distribution of important ores and other economic minerals in India.

SUGGESTED READINGS:

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley 4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, TataMcGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

Syllabus for Geology Minor Course

Semester-V

COURSE TITLE: Earth Resource

Course Code: GEOMI-051
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**
Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20)**
In Semester Assessment: **30**

Learning Objective: *To acquire a understanding of Earth resources.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the concept of resource and their classifications. The students will also learn about the precesses of formation of ore mineratl and different energy sources.*

THEORY:

Unit 1: **Marks: 10** **No of Classes:09**

Earth Resources, Resource reserve definitions; mineral, energy and water resources in industries. Historical perspective and present. A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies

Unit 2 **Marks: 10** **No of Classes:09**

Ore and gangue minerals; Grade and tenor of ore

Ore forming processes: Endogenous processes- Magmatic concentration, skarns, and hydrothermal deposits; Exogenous processes- weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit 3: **Marks: 10** **No of Classes:09**

Definition of Energy: Primary and Secondary Energy Difference between Energy, Power and Electricity Renewable and Non-Renewable Sources of Energy. The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy.

Unit 4: **Marks: 10** **No of Classes:09**

Major Types and Sources of Energy, Resources of Natural Oil and Gas. Coal and Nuclear Minerals. Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy.

Unit 5: **Marks: 10** **No of Classes:09**

Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave- General Principles. Ground water resources and its role in economic development of a country Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Megascopic study of ore minerals in hand specimen
Plotting of major Indian oil fields and mineral deposits on map of India
Problems related to hydroelectric power generation
Problems related to assessment of possible oil exploration site from geological maps
Problems related to energy demand projection of India and possible mitigation pathways
Problems related to biofuel

SUGGESTED READINGS:

1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill
2. Global Energy Perspectives by NebojsaNakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M. A. Prelas. 2009, Springer
4. Introduction to Wind Energy Systems: Hermann-Josef Wagner and JyotirmayMathur. 2009, Springer.
5. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.

Syllabus for Geology Major Course

Semester-VI

COURSE TITLE: Geodynamics and Tectonics
Course Code: GEOMJ-044

Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination: **70 (Theory: 50 and Practical: 20)**
In Semester Assessment: **30**

Learning Objective: *To acquire a holistic understanding of dynamics of the planet Earth and the concept of plate tectonics*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the dynamism of the planet and the concept of lithospheric plates and plate tectonics. The students will also learn about different features associated with different plate tectonic settings*

THEORY:

Unit 1: Introduction **Marks: 08** **No of Classes: 07**
Earthquakes, Seismic waves and internal constitution of the Earth; Lithosphere: continental and oceanic lithosphere, Rheology of the lithosphere: Elastic deformation, bending and buckling of lithospheric plates, Lithosphere as a thermal boundary layer.

Unit 2: The Dynamic Earth **Marks: 10** **No of Classes: 09**
Constitution of the core and mantle, heat flow and convection patterns; Gravity anomalies and the Concept of isostasy; Earth's magnetic field; Geothermal gradient and internal heat flow of the Earth. Concept of Hot spot and plumes.

Unit 4: Plate and Plate Boundaries **Marks: 12** **No of Classes: 11**
Distribution of plates in the Earth, physical character of plates. Macro and micro plates. Plate boundaries: types, character, identification of boundaries, Motion along plate boundaries. Triple junction, Kinematics of plate motion, Rate of plate motion. Volcanic arcs, island arcs, trenches, accretionary prisms, oceanic ridges, transform faults, Magmatism and earthquake in oceanic ridges and in subduction zones.

Unit 5: Plate Tectonics **Marks: 10** **No of Classes: 09**
Plate Tectonics- Past and Present: Plate tectonics model and its evidences. Reconstruction of plates. Supercontinent, their break up and assembly. Assembly and break up of Pangaea. Wilson cycle. Driving Mechanisms of plates, Plate tectonics and mantle convection.

Unit 5: Features Associated with Different Tectonic Setting
Marks: 10 **No of Classes: 09**

Convergence Setting: Trenches, Island arcs and continental arcs, Mountain ranges
Divergent setting: Rift valley, Mid-oceanic ridges
Transform Boundaries; Transcurrent and transform faults, flower structures, slag pond, shutter ridge, beheaded rivers

PRACTICALS: **Marks: 20** **No of Classes: 15**
Study of Tectonic maps of India
Stability analysis of plate boundaries

Paleogeographic Reconstruction

COURSE TITLE: ENGINEERING GEOLOGY
Course Code: GEOMJ-062
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100
End Semester Examination: **70 (Theory: 50 and Practical: 20)**
In Semester Assessment: **30**

Learning Objective: *To acquire an understanding of different engineering properties of rock and soil as well as geological characteristics for major constructions.*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of the processes of foundation treatment, classification of rock on the basis of engineering properties, as well as its geological, geotechnical and environmental considerations of major engineering projects.*

THEORY:

Unit 1: Introduction to Engineering Geology **Marks: 08** **No of Classes:07**
Engineering Geology and its Scope.
Site investigation and characterization: Environment impact assessment (EIA); Detailed project report (DPR)

Unit 2: Engineering Properties of rocks and Soil **Marks: 08** **No of Classes:07**
Foundation treatment; Grouting, Rock Bolting and other support mechanisms, Intact Rock and Rock Mass and soil properties. Rock aggregates; Significance as Construction Material. Introduction to alkali aggregate reaction.

Unit 3: Significance of Rock Mass Classification **Marks: 10** **No of Classes:10**
Concept of rock mass classification,
Concept, Mechanism and Significance of

a) Rock Quality Designation (RQD)
b) Rock Structure Rating (RSR)
c) Rock Mass Rating (RMR)
d) Tunneling Quality Index (Q)
e) Geological Strength Index (GSI)

Unit 4: Engineering structures **Marks: 12** **No of Classes:12**
Dam and types. Geological, Geotechnical and Environmental considerations associated with Dams and Reservoirs

Road and Bridge: Geological and geotechnical considerations associated with Roads and Bridges. Tunnel: NATM and other tunnelling methods, tunnel support systems. Geological and geotechnical considerations associated tunnelling.
Case histories related to Indian Civil Engineering Projects. Role of Engineering geologists in planning, design and construction of major man-made structural features.

Unit 5: Slope failure and mitigation measures **Marks: 12** **No of Classes:09**
Landslides; Stability of slopes; Causes, Factors and corrective/Preventive measures, Earthquakes; Causes, Factors and corrective/Preventive measures; Implementation of Safety Measures and Hazard Mitigation Strategies in High-Seismic Zones of India (Seismic design of buildings).

PRACTICALS: **Marks: 20** **No of Classes: 15**

Computation of reservoir area, catchment area, reservoir capacity and reservoir life. Computation of index properties of rocks.
Computation of RQD, RSR, RMR and 'Q'.

SUGGESTED READINGS:

1. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
2. Johnson, R.B. and De Graf, J.V. 1988. Principles of Engineering Geology, John Wiley.
3. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley &

Sons, N.Y.
4. Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.
5. Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
6. Bell, .F.G, 2007. Engineering Geology, Butterworth-Heineman

COURSE TITLE: REMOTE SENSING AND GIS
Course Code: GEOMJ-063
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20)**
In Semester Assessment:	**30**

Learning Objective: *To acquire an understanding Remote sensing and GIS and their application*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of photogeology and identification of different features in aerial photograph. They will also have some kholowdge on chateristics of different satellite and their data formats and also will have the idea of different image processing techniques. The students will be introduced to GIS, projection and coordinate systems, DEM and GPS*

THEORY:

Unit 1: Photogeology **Marks: 10** **No of Classes:07**
Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion, image parallax. Elements of air photo interpretation. Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

Unit 2: Remote Sensing **Marks: 10 No of Classes:07** Concepts in Remote Sensing, Sensors and scanners. Satellites, their characteristics and data format. Data formats- Raster and Vector. Indian Remote Sensing Satellites.

Unit 3: Digital Image Processing **Marks: 12 No of Classes:07** Image Errors, Rectification and Restoration, FCC, Image Enhancement, Filtering, Image Rationing, Image classification and accuracy assessment.
GIS integration and Case studies-Indian Examples.

Unit 4: GIS **Marks: 10 No of Classes:07** Datum, Coordinate systems and Projection systems. Spatial data models and data editing. Introduction to DEM analysis.

Unit 5: GPS **Marks: 08** **No of Classes:07**
Concepts of GPS
Integrating GPS data with GIS
Applications in earth system sciences

PRACTICALS: **Marks: 20** **No of Classes: 15**

- Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms
- Introduction to DIP and GIS softwares.
- Digital Image Processing exercises including analysis of satellite data in different bands and interpretation of various objects on the basis of their spectral signatures Creating a FCC
  from raw data,
- Registration of satellite data with a toposheet of the area.
- Enhancing the satellite images; Generating NDVI images and other image ratio and its interpretation.
- Classification of images.
- DEM analysis: generating slope map, aspect map and drainage network map and its applications.

SUGGESTED READINGS:

1. Demers, M.N., 1997. Fundamentals of Geographic Information System, John Wiley & sons. Inc.
2. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory & Practice, Springer Wien New York.
3. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.
4. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.
5. Richards, J.A. and Jia, X., 1999. Remote Sensing Digital Image Analysis, Springer-Verlag.

COURSE TITLE: GEOMORPHOLOGY

Course Code: GEOMJ-064
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination:	**70 (Theory: 50 and Practical: 20) In**
Semester Assessment:	**30**

Learning Objective: *To acquire an understanding on geomorphological processes and landscape evolution*

Learning Outcome: *At the end of the course the student will have knowledge and understanding of concept of geomorphology and geomorphological processes, landform, and basic knowledge on Indian geomorphology*

THEORY:

Unit 1: Introduction **Marks: 08** **No of Classes:07**
Geomorphology and Geomorphological Processes. Endogenic and Exogenic processes

Unit 2: **Marks: 10** **No of Classes:07**
Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features. Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya).

Unit 3: **Marks: 12** **No of Classes:07**
Exogenic Surficial Processes and geomorphology, Weathering and associated landforms, Hill slopes, Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities.

Unit 4: **Marks: 10** **No of Classes:07**

Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development.

Unit 5: **Marks: 10** **No of Classes:07**

Overview of Indian Geomorphology with special reference to NE India, Extra-terrestrial landforms.

PRACTICALS: **Marks: 20** **No of Classes: 15**

Reading topographic maps, Concept of scale Preparation of a topographic profile, Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index, Morphometry of a drainage basin, Calculating different morphometric parameters, Preparation of geomorphic map, Interpretation of geomorphic processes from the geomorphology of the area.

SUGGESTED READINGS

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

COURSE TITLE: FIELD WORK

Course Code: GEOMJ-065
Credits: 02 (Practical- 02) **No. of Classes:**

Marks: Total 50

Practical: 50 (Field Report 35 and Internal Assessment: 15) SUGGESTED READINGS:

1. Coe, A. L. (2010) Geological Field Techniques, Wiley Blackwell
2. Bauer, W. (2015) Geological Field Manual: A practical guide for students and enthusiasts
3. Compton, R. R. (1962) Manual of Field Geology, John Wiley & Sons Inc
4. Lambert, D (2007)A Field Guide To Geology: Updated Edition

Syllabus for Geology Minor Course

Semester-VI

COURSE TITLE: EARTH CLIMATE AND ENVIRONMENT
Course Code: GEOMI-061
Credits: 04 (Theory- 03 + Practical- 01) **No. of Classes: 75 (T-45+ P-30)**

Marks: Total 100

End Semester Examination: 70 (Theory: 50 and Practical: 20)

In Semester Assessment: 30

Learning Objective: *To acquire an understanding of the climate system and its controls*

Learning Outcome: *At the end of this course the student will acquire knowledge on the climate system ant its components, different sphears of the earth, and iys control on climate. The student will also learn different climate-controlling factors and their impact on the environment*

THEORY:

Unit 1: Introduction **Marks: 08** **No of Classes:07**

Climate system: Forcing and Responses, Components of the climate system Climate forcing, Climate controlling factors. Climate system response, response rates and interactions within the climate system. Feedbacks in climate system.

Unit 2: **Heat budget of Earth** **Marks: 10** **No of Classes:08**

Heat budget of Earth, Incoming solar radiation, receipt and storage of heat. Heat transformation. Earth's heat budget. Interactions amongst various sources of earth's heat.

Unit 3: Atmosphere **Marks: 13** **No of Classes: 10**

Atmosphere – Hydrosphere. Layering of atmosphere and atmospheric Circulation. Atmosphere and ocean interaction and its effect on climate. Heat transfer in ocean. Global oceanic conveyor belt and its control on earth's climate. Surface and deep circulation. Sea ice and glacial ice.

Unit 4: climate change **Marks: 13** **No of Classes: 10**

Response of biosphere to Earth's climate. Climate Change: natural vs. anthropogenic effects. Humans and climate change. Future perspectives. Brief introduction to archives of climate change. Archive based climate change data from the Indian continent.

Unit 5: Orbital cyclicity and climate **Marks: 06** **No of Classes: 10**

Orbital cyclicity and climate. Milankovitch cycles and variability in the climate Glacialinterglacial stages. The Last Glacial maximum (LGM). Pleistocene Glacial-Interglacial cycles. Younger Dryas. Marine isotope stages. Monsoon. Mechanism of monsoon. Monsoonal variation through time. Factors associated with monsoonal intensity. Effects of monsoon.

PRACTICALS: **Marks: 20** **No of Classes: 15**

1. Study of distribution of major climatic regimes of India on map
2. Distribution of major wind patterns on World map
3. Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals
4. Numerical exercises on interpretation of proxy records for paleoclimate

SUGGESTED READINGS:

1. Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
2. Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlatt
3. Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
4. Aguado, E., and Burt, J., 2009. Understanding weather