SE-MESTER	COURSE	COURSE NAME	COURSE CODE	CREDIT
I	MJ-1	Essentials of Geology (Theory)		3
		Essentials of Geology (Practical)		1
II	MJ-2	Crystallography & Mineralogy (Theory)		3
		Crystallography & Mineralogy (Practical)		1
III	MJ-3	Geomorphology (Theory)		3
		Geomorphology (Practical)		1
	MJ-4	Structural Geology (Theory)		3
		Structural Geology (Practical)		1
IV	MJ-5	Igneous Petrology (Theory)		3
		Igneous Petrology (Practical)		1
	MJ-6	Sedimentary Petrology (Theory)		3
		Sedimentary Petrology (Practical)		1
	MJ-7	Paleontology (Theory)		3
		Paleontology (Practical)		1
	MJ-8	Geology Of Nagaland (Theory)		3
		Field work I- Basic Field Training		1
V	MJ-9	Metamorphic Petrology (Theory)		3
		Metamorphic Petrology (Practical)		1
	MJ-10	Indian Stratigraphy (Theory)		3
		Indian Stratigraphy (Practical)		1
	MJ-11	Hydrogeology & Engineering Geology (Theory)		3
		Hydrogeology & Engineering Geology (Practical)		1
VI	MJ-12	Economic Geology (Theory)		1
		Economic Geology (Practical)		3
	MJ-13	Fuel Geology(Theory)		1
		Fuel Geology (Practical)		3
	MJ-14	Remote Sensing And GIS (Theory)		3
		Remote Sensing And GIS (Practical)		1
	MJ-15	Geological Fieldwork		4

VII	MJ-16 DSE-1	Geochemistry (Theory) OR Introduction To Geophysics (Theory)		3
		Geochemistry (Practical) OR Introduction To Geophysics (Practical)		1
	MJ-17 DSE-2	Exploration Geology (Theory) OR Urban Geology (Theory)		3
		Exploration Geology (Practical) OR Urban Geology (Practical)		1
	MJ-18 DSE-3	Environmental Geology (Theory) OR Evolution Of Life Through Time (Theory)		3
		Environmental Geology (Practical) OR Evolution Of Life Through Time (Practical)		1
	MJ-19 DSE-4	Introduction to Research Methodology Research and Publication Ethics (Theory) OR Marine Geology (Theory)		3
		Introduction to Research Methodology Research and Publication Ethics (Practical) OR Marine Geology (Practical)		1
VIII	MJ-20	Geology of North East India (Theory)		3
		Geology of North East India (Practical)		1
	MJ-21	Ore Geology & Mining (Theory)		3
		Ore Geology & Mining (Practical)		1
	MJ-22	Geodynamics & Tectonic Geomorphology (Theory)		3
		Geodynamics & Tectonic Geomorphology (Practical)		1
	MJ-23	Optical Mineralogy & Gemology (Theory)		3
		Optical Mineralogy & Gemology (Practical)		1
		OR		
		Research Project or Dissertation		12
				92

SEMESTER – I
MJ – 1
ESSENTIALS OF GEOLOGY

UNIT I
Introduction to various branches of Geology.
Earth in the solar system: origin, size, shape, mass, density, rotational and revolutional parameters.
Structure of the earth.
Formation of core, mantle, crust atmosphere, hydrosphere and biosphere.
Terrestrial and Jovian planets.

UNIT II
Convection in the earth's core and production of magnetic field.
Concept of Plate tectonics: Continental drift and Seafloor spreading.
Mid-oceanic ridges, Trenches, Magmatic arcs, Transform faults.
Concept of Isostasy.
Earthquakes and Seismic waves.
Volcanoes: Types, products and their distribution.

UNIT III
Nature of stratigraphic records: Law of Superposition, Law of Original Horizontality, Law of Lateral Continuity, Law of Faunal Succession.
Nature of Cross-cutting relationships and Stratigraphic Contacts: Vertical, Horizontal, Intrusive.
Unconformities and Types.
Uniformitarianism, Catastrophism, Plutonism and Neptunism.
Basic concepts of Lithostratigraphy, Biostratigraphy, and Geochronology.
Chronostratigraphy and the Geological time scale.

UNIT IV
Practical Credit: 1

Study of major geomorphic features and their relationships with outcrops through physiographic models.
Study of distribution of major lithostratigraphic units on the map of India
Study of major ocean currents of the World
Problems on plate tectonics

SUGGESTED READINGS:
Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor & Francis.
Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.
Gross, M. G. (1977). Oceanography: A view of the earth

SEMESTER – II
MJ - 2
CRYSTALLOGRAPHY & MINERALOGY

UNIT-I
Elementary ideas about crystal morphology in relation to internal structures.
Crystal parameters and indices
Crystal symmetry
Study of normal classes of the Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic systems.

UNIT-II
Minerals –Definition, classification and physical properties.
Silicate structures.
Study of common rock forming minerals – Silica, Feldspar, Olivine, Pyroxene, Amphibole, Mica, Aluminosilicate and Garnet family.

UNIT-III
Isomorphism, Polymorphism and Pseudomorphism
Introduction to petrological microscope
Isotropic and anisotropic minerals
Refractive index, birefringence, pleochroism, interference colour, extinction and twinning.

UNIT-IV
PRACTICAL
1. Observation and documentation on symmetry of crystals
2. Study of physical properties of minerals in hand specimen
3. Silicates: Olivine, Garnet, Andalusite, SilIimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite
4. Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal. Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
5. Study of some key silicate minerals under optical microscope and their characteristic properties

Recommended Books and References:
1. Klein, C., Dutrow, B., Dwight, J., & Klein, The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons. 225
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.

SEMESTER-III
MJ-3
GEOMORPHOLOGY

UNIT I
Introduction to Geomorphology, Endogenic- Diastropism and Exogenic processes- Degradational, Aggradational, Anthropogenic processes.
Topography, Large Scale Topography - Ocean basins, Large scale mountain ranges (with emphasis on Himalaya).

UNIT II
Rates of uplift and denudation, Tectonics and drainage development, Sea-level change.
Long-term landscape development: Davis, King's and Planck's model.
Overview of Indian Geomorphology.

UNIT III
Weathering and associated landforms. Glacial processes and landforms. Fluvial processes and landforms. Aeolian processes and landforms. Coastal processes and landforms. Underground water and associated landforms.

UNIT-IV
Practical Credit: 1

Reading topographic maps; Concept of scale; Preparation of a topographic profile; Preparation of longitudinal profile of a river; Morphometry of a drainage basin; Calculating different morphometric parameters; Preparation of geomorphic maps; Interpretation of geomorphic processes from the geomorphology of the area.

Recommended Books and References:
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.
3. W.D.Thornburry: Principles of Geomorphology.
4. Richard John Huggett: Fundamentals of Geomorphology

SEMESTER-IV
MJ-4
STRUCTURAL GEOLOGY

Unit-I

Orientation of planes and lines in space-concept of dip, strike, rake and plunge. Contour lines; Rule of V's and outcrop patterns. Interpretation of geological maps and cross-section construction. Topographic and structural maps; important representative factors of maps.

Unit-II

Concept of rock deformation: Stress and strain in rocks. Brittle and ductile deformation. Planar and linear structures. Fold morphology; Geometric and genetic classification of folds.

Unit-III

Geometric and genetic classification of faults. Effects of faulting on the outcrops. Criteria for recognition of faults.
Geometric and genetic classification of joints.

UNIT IV
Practical Credit: 1

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

Recommended Books and References:

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)

SEMESTER V

MJ-5

IGNEOUS PETROLOGY

UNIT I

Introduction to Igneous petrology: Geothermal gradient. Origin and nature of magma; magmatic differentiation and assimilation. Bowen's reaction series. Textures and structures of igneous rocks, Mode of occurrence of igneous rocks.

UNIT II

Classification of igneous rocks: mineralogical and chemical classification. Phase diagrams and petrogenesis: Phase rule and Lever's rule. Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic magmas.

UNIT III

Magmatism in different tectonic settings: MORB, OIB, Island arcs and continental arcs.
Petrogenesis of felsic, mafic and ultramafic igneous rocks: Granite, Basalt and Komatiites. Alkaline rocks: Kimberlites and Lamproites.

UNIT-IV

Practical Credit: 1

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite,

Recommended Books and References:

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.

MJ-6
SEDIMENTARY PETROLOGY

UNIT I
Weathering: Physical, chemical and biological weathering.
Classification of sedimentary rocks. Textures, Grain size scale, particle size distribution, particle shape and fabric. Laminar and turbulent flow, transportation and deposition.

UNIT II
Allogenic and autogenic controls on sedimentation.
Erosional and Depositional sedimentary structures.
Palaeocurrent analysis: Palaeocurrents for different sedimentary environments.
Concept of sedimentary facies.

UNIT III
Siliciclastic rocks: Conglomerates, sandstones, mudrocks. Carbonate rocks: limestone and its classification, dolomite and dolomitisation
Concepts and stages of diagenesis: Compaction, cementation and authigenesis / neomorphism.

UNIT-IV
Practical Credit: 1

Exercises on sedimentary structures. Particle size distribution and statistical treatment
Paleocurrent analysis Petrography of clastic and non-clastic rocks through hand specimens andthin sections

Recommended Books and References:
1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimenary Petrology, Blackwell Publishing.
1. 3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
3. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell

MJ-7
PALAEONTOLOGY

Unit-I

Fossilization and fossil record. Modes of preservation. Binomial nomenclature. Concept of Taphonomy. Ichnology. Application of Fossils in stratigraphy: Biozones, index fossils and its correlation.

Unit-II

Morphology and evolutionary trends in Molluscs (Pelecypoda, Gastropoda, Cephalopoda). Brachiopoda. Echinodermata and Trilobites.

Unit-III

Introduction to Gondwana Flora and fauna.
Mass Extinction in Phanerozoic life: Ordovician-Silurian, Devonian, Permian-Triassic, Triassic-Jurassic and Cretaceous-Tertiary extinction.
Evolution trends and sequence of horse and humans.

UNIT IV
Practical Credit: 1

1. Study of fossils showing various modes of preservation
2. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrates, vertebrates and plant fossils

Recommended Books and References:

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

MJ-8

GEOLOGY OF NAGALAND

Unit-I

Introduction to geology of Nagaland: History, Physiography, stratigraphy and tectonic setting.

Unit-II

Schuppen Belt and Inner Fold Belt: Structure and lithounits. Ophiolite Belt: Structure, lithounits and tectonic setting.

Unit-III

Mineral resources of Nagaland: Coal, petroleum, limestone, metalliferous deposits and dimensional stones.

UNIT IV
Practical Credit: 1
Basic Field Training

Recommended Books and References:

1. Geology of India and Burma – M.S. Krishnan, 1982. CBS Publishers & Distributors.
2. Fundamentals of Historical Geology and Stratigraphy of India – Ravindra Kumar.
3. Geology of India – D.N. Wadia. Tata McGraw Hill Publishing.
4. Phanerozoic Ophiolites of India – P.C. Ghose. Sumna Publishers & Distributors,

SEMESTER-V

MJ-9

METAMORPHIC PETROLOGY

Theory Credit: 3

UNIT I

Metamorphism, Factors controlling metamorphism.

Types of metamorphism- contact, regional, burial, fault zone metamorphism, impact metamorphism.

Structure and textures of metamorphic rocks.

Metasomatism and role of fluids in metamorphism.

UNIT II

Chemographic projections: ACF, AKF and AFM. Mineralogical phase rule.

Prograde and retrograde metamorphism. Pressure-Temperature-time path.

Brief idea of anatexis and origin of migmatites.

Paired metamorphic belts.

UNIT III

Concept of metamorphic facies and grade. Index minerals.

Metamorphic rock associations- schists, gneisses, khondalites, charnockites, eclogites, quartzite and marble.

UNIT-IV

Practical Credit: 1

Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks:

Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite quartz schist, slate, talc, tremolite, calcite-quartz schist.

Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble.

Laboratory exercises in graphic plots for petrochemistry and interpretation of assemblages.

Recommended Books and References:

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. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

MJ-10

STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Theory Credit: 3

UNIT I

Principles of Stratigraphy. Fundamentals of Litho-, Bio- and Chronostratigraphy. Code of stratigraphic nomenclature. Stratotypes. Concepts of palaeogeographic reconstruction.

Important Stratigraphic boundaries in India: Precambrian-Cambrian boundary, Permian-Triassic boundary and Cretaceous-Tertiary boundary.

UNIT II

Study of following Precambrian successions: Dharwar, Aravalli, Cudappah, Vindhyan and Delhi supergroups.

Palaeozoic succession of Spiti.

Mesozoic succession of Spiti, Jurassic of Kutch, Cretaceous of Trichinopoly.

UNIT III

Tertiary sequence of Siwaliks.

Volcanic provinces of India: Deccan, Rajmahal and Sylhet Trap.

Gondwana Supergroup. Cenozoic Himalayas. Cenozoic stratigraphy of Assam.

UNIT-IV

Practical Credit: 1

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.

Recommended Books and References:

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.

MJ-11

HYDROGEOLOGY AND ENGINEERING GEOLOGY

Theory Credits:3

UNIT I

Origin of groundwater
Hydrologic cycle, precipitation, evapotranspiration, run-off, interception and infiltration.
Rock properties affecting groundwater.
Aquifer parameters, Types of aquifers.
Geological formations as aquifers.

UNIT II

Vertical distribution of subsurface water.
Darcy's law, Laminar and turbulent groundwater flow.
Surface-based groundwater exploration methods.
Physical and chemical properties of water and water quality.
Springs, Hydrothermal phenomenon, Groundwater in permafrost region.

UNIT III

Role of Geology in Engineering.
Engineering properties of rocks.
Site investigation and characterization (relief, lithology, structures, ground water conditions).
Rock aggregates: significance as construction material.
RQD (Rock Quality Designation).
Geological considerations in the construction of Dams and Tunnels.

UNIT-IV

Practical Credit: 1

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: the determination of permeability in the field and laboratory, Groundwater flow, Well hydraulics, etc.
Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
Merits, demerits & remedial measures based upon geological cross sections of project sites.
Computation of Index properties of rocks.
Computation of RQD, RSR, RMR and 'Q'

Recommended Books and References:

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

4. McGraw- Hill Pub. Co. Ltd.
5. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique,McGraw Hill (CBS Publ).
6. Johnson, R.B. and De Graf, J.V. 1988. Principles of Engineering Geology, John Wiley.
7. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley &Sons, N.Y.
8. Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
9. Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
10. Bell, .F.G, 2007. *Engineering Geology,* Butterworth-Heineman

SEMESTER-VI

MJ-12

ECONOMIC GEOLOGY

Theory Credits:3

UNIT I

Ores, gangue minerals, tenor, assay value, grade. Resources and Reserves. Metallogenetic provinces and Epochs. Essentials, Critical and Strategic Minerals. Textures and structures.

UNIT II

Processes of formation of ore deposits: Magmatic, hydrothermal, metamorphic, sedimentation, residual and mechanical concentration, and oxidation and supergene enrichment.

UNIT III

Chemical composition, occurrence, origin, use and distribution of the following economic mineral deposits in India: Iron, Manganese, Chromium, Copper, Gold, Magnesite and limestone.

UNIT-IV

Practical Credit: 1

Megascopic identification
Study of microscopic properties of ore-forming minerals (Oxides and sulfides).
Preparation of maps: Distribution of important ores and other economic minerals in India.

Recommended Books and References:

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, Tata-McGraw 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.

MJ-13

FUEL GEOLOGY

Theory Credits: 3

UNIT I

Definition and origin of Coal. Basic classification of coal. Introduction to lithotypes, micro lithotypes and macerals in coal, Proximate and Ultimate analysis. Coal Bed Methane (CBM).

UNIT II

Origin of crude oil. Chemical composition and physical properties of crude oil. Migration of crude oil and its types. Cap rocks- definition and general properties. Reservoir rocks- clastic and chemical. Hydrocarbon traps.

UNIT III

Radioactive minerals: Origin of Uranium and Thorium bearing minerals, reserves in India and its applications. Nuclear waste disposal. Gas Hydrates.

UNIT IV

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Plot the different sedimentary basins and nuclear minerals on the outline map of India.
4. Prepare structural contour maps
5. Reserve estimation of crude oil

Recommended Books and References:

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
3. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
4. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

MJ-14
SEMESTER-VI
REMOTE SENSING AND GIS
Theory Credits: 3

UNIT I

Concepts and components in Remote Sensing.
Relief displacement, vertical exaggeration, and distortion.
Electromagnetic Spectrum.
Sensors and scanners.
Types and acquisition of aerial photographs.
Scale and resolution.

UNIT II

Aerial photo interpretation.
Identification of sedimentary, igneous and metamorphic rocks.
Digital image processing. Pre-processing: Radiometric correction, Geometric correction, Image processing systems. Image Enhancement, Filtering, Image Rationing.

UNIT III

GIS: Definition, Datum, Coordinate systems, and Projection systems. Application of GIS in geoscience.
GPS: Introduction and working principle.
Applications of GPS in Geoscience.

UNIT-IV

Practical Credit: 1

Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms
Introduction to DIP software. 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
GIS: Introduction to basic GIS software and demonstration.

Recommended Books and References:

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.
6. Stephen R Galati. Geographic Information System Demystified.

MJ-15

GEOLOGICAL FIELDWORK

Credits: 4

The paper will be based on geological field training in which the students will be trained on the following aspects:

1. Geological mapping techniques, understanding the interaction between topography and geologic structures.

2. Basic of field data collection analyses, interpretation and geological report writing.

SEMESTER VII

DISCIPLINE SPECIFIC ELECTIVE 1 / MJ-16
GEOCHEMISTRY

Theory Credit: 3

UNIT I

Geochemistry: Definition, Elements, atoms and chemical bonding.
Geochemical periodic table. Goldschmidt classification of elements.
Radiogenic isotopes geochemistry.
Radioactive decays; Alpha, Beta, Gamma, Electron Capture, Spontaneous Fission.
Radioactive decay equation and Geochronology.

UNIT II

Stable isotopes geochemistry: Introduction and Scope.
Delta notation and Fractionation factor.
Marine Quaternary $\delta^{18}O$ record.
Rare Earth Elements and its applications.

UNIT III

Major, Minor and trace elements and its applications.
Composition of the bulk silicate Earth. Meteorites.
Geochemical behavior of selected elements like Si, Al, Fe K, Na and Mg

UNIT IV

Practical Credit: 1

Types of geochemical data analysis and interpretation; of common geochemical plots.
Geochemical analysis of geological materials.
Geochemical variation diagrams and its interpretations.
Calculation of radioactive decay constant, half-life and parent to daughter ratios.
Exercises on behavior of elements in a melt.

Recommended Books and References:

1. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
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. W.M.White Geochemistry

DISCIPLINE SPECIFIC ELECTIVE 1
MJ-16
INTRODUCTION TO GEOPHYSICS
Theory Credit: 3

UNIT I
Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining geodynamical features of the earth. Concepts and Usage of corrections in geophysical data.
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications.

UNIT II
Different types of surveys, grid and route surveys, profiling and sounding techniques. Scales of survey, Presentation of geophysical data. Oil and gas geophysics and groundwater geophysics.

UNIT III
Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration

UNIT-IV
Practical Credit: 1
1. Anomaly and background- Graphical method
2. Study and interpretation of seismic reflector geometry
3. Problems on gravity anomaly

Recommended Books and References:
1. Outlines of Geophysical Prospecting - A manual for geologists by RamachandraRao,M.B., Prasaranga, University of Mysore, Mysore, 1975.
2. Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration
Geophysicists, Osmania University, Hyderabad, 1990.
3. Dobrin, M.B. (1984) An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
4. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics* (Vol. 1). Cambridge
university press.
5. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

DISCIPLINE SPECIFIC ELECTIVE 2
MJ-17
EXPLORATION GEOLOGY
Theory Credits: 3

UNIT I
Resources and Reserves. Prospecting and exploration-concept, methodology and stages. Geological mapping and sampling methods. Geochemical exploration method.

UNIT II
Remote sensing. Principles of Geophysical prospecting methods (Gravity, Magnetic, Seismic and Resistivity methods). Core and Non-core drilling. Planning of bore holes and Core-logging

UNIT III
Reserve estimations and Errors. Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks). Principles of Mineral economics: strategic, critical and essential minerals. National and domestic mineral policies. Marine mineral resources.

UNIT IV
Practical Credit: 1
1. Seismic prospecting exercises
2. Gravity prospecting exercises
3. Geological contour map and cross-section
4. Ore reserve estimation methods

Recommended Books and References:
1. Mineral exploration: Principles and Applications. S.K Haldar
2. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
3. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
4. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing

DISCIPLINE SPECIFIC ELECTIVE 2
MJ-17
URBAN GEOLOGY
Theory Credit: 3

UNIT I
Geology in Urban Constructions. Geotechnical feature and mapping for subsurface in Metropolitan areas. Building materials, Excavation and cutting in urban areas. Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer. Effect of pollutants on vegetable contamination.

UNIT II
Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban land use, Geological problems in construction of underground structures in urban areas. Water lagging in built-up areas, Source of water, Standards for various uses of water. Sources of contamination.

UNIT III
Waste waters: Sources and its disinfection and treatment.
Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Need for special purpose mapping for selection of waste disposal sites.

UNIT IV
Practical Credit: 1

1. Map Reading
2. Ground water flow direction estimation
3. Case studies of Urban flood; Flood hydrographs
4. Case studies of urban planning

Recommended Books and References:
1. Huggenberger, P. and Eptin, J. 2011 Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management. Springer
2. Lollino, G. et al. (Ed.), Engineering Geology for Society and Territory. Springer

DISCIPLINE SPECIFIC ELECTIVE 3

MJ-18

ENVIRONMENTAL GEOLOGY

Theory Credit: 3

UNIT I

Introduction to environmental geology. Geology a basic environment awareness. Earth as a system, Sustainability and limitation of resources.

Elementary concepts on springshed and watershed management. Environmental impact assessment.

UNIT II

Geological hazards: Primary and secondary hazards, Seismic engineering, easy warning systems, Planning and education. Stabilizing hill slopes and controlling landslides, Vulnerability zone, types and mitigation measures.

UNIT III

Anthropogenic hazard: causes, impact and preventive measures on deforestation.

Geo- environmental Problems of NE India: Geological and topographic characteristics, climate, drainage, groundwater, soil, land use, land capability, forest cover and their mitigation.

UNIT IV

Practical Credit: 1

Case studies on population growth, deforestation, water and air pollution, earthquake zones of the world, landslide zonation maps and geo environmental problems of North east India.

Recommended Books and References:

1. Environmental Geology - E.A. Keller.
2. Environmental Problems and Solutions - D.K. Asthana.
3. Environmental Science and Engineering – R. Sivakumar.
4. Ecology and Environment - P.D. Sharma.

DISCIPLINE SPECIFIC ELECTIVE 3

MJ-18

EVOLUTION OF LIFE THROUGH TIME

Theory Credit: 3

UNIT I

Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio-events. Fossilization processes and modes of fossil preservation. Biogeochemical cycles. Microbes mineral interactions, microbial mats.

UNIT II

Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life. Precambrian macrofossils – The garden of Ediacara.
The Cambrian Explosion. Origin of vertebrates and radiation of fishes. Origin of tetrapods - Life out of water.

UNIT III

Early land plants and impact of land vegetation. Life after the largest (P/T) mass extinction, life in the Jurassic seas. Origin of mammals. Rise and fall of dinosaurs. Origin of birds; and spread of flowering plants.

UNIT IV

Practical Credit: 1

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants

Recommended Books and References:

1. Stanley, S.M., 2008 Earth System History
2. Jonathan I. Lumine W. H. Freeman Earth-Evolution of a Habitable World, Cambridge University Press.
3. Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology Blackwell
4. Cowen, R., 2000 History of Life, Blackwell

DISCIPLINE SPECIFIC ELECTIVE 4

MJ-19

Introduction to Research Methodology Research and Publication Ethics

Unit I

Research Methodology: Meaning, objectives and types of research. Research approach and significance. Research Methods versus Methodology. Research and Scientific method. Criteria of Good research. Problems encountered by researches in India.

Unit II

Research Ethics: Introduction to Ethics and Philosophy. Principles of Ethical Research. Plagiarism. Scientific Misconduct and types.

Publication Ethics: Definition and Concept. Committee on Publication Ethics (COPE). Directory of Open Access Journals (DOAJ). Publication Misconducts.

Unit III

Open Access Publications and Initiatives. Predatory Publishing. Journal finder tools: Journal/ Author Name Estimator (JANE), Elsevier Journal Finder, Springer Journal Suggester. Overview of Copyright Transfer Agreement and SHERPA/RoMEO.

Unit IV

Practical

Group Discussion: Subject specific ethical issues, FFP, Authorship. Conflicts of Interest; Complaints and appeals: examples and fraud from India and abroad.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Citation Databases: Web of Science, Scopus, Google Scholar. Research Metrics: Impact Factor (IF), SNIP, SJR, IPP, Cite Score.

Suggested Readings:

1. C.R. Kothari. Research Methodology, Methods and Techniques (Second Revised Edition) New Age International Publisher 2004. ISBN (13): 978-81-224-2488-1.
2. Nimit Chowdhary and Sarah Hussain. Handbook of Research and Publication Ethics. Bharti Publications Second Reprint, 2022. ISBN: 978-93-90818-53-2.

DISCIPLINE SPECIFIC ELECTIVE 4
MJ-19
MARINE GEOLOGY
Theory Credits: 3

UNIT - I

Ocean morphology, deep ocean floor and various topographic features: ridges, sea mounts, coral reefs, continental shelf, continental slope, trenches and canyons.
Oceanic circulation, waves and currents.

UNIT - II

Oceanic sediments: pelagic sediments and abyssal plain sediments.
Oceanic sediments and distribution of marine microfossils; stratigraphy and geochronometry of deep-sea deposits.

UNIT - III

Movements of the sea floor, structure of the ocean basins, Tectonic history and chemistry of oceanic rocks. Igneous rocks of the ocean basin, Mineral resources of the oceans.
Geophysical techniques for the exploration of the sea floor.

UNIT- IV
PRACTICAL
Study of Rose diagram.
Study of annual wave period percentage frequencies and plot it on Bar diagram.
Study the pattern of tides and currents.

Recommended Books and References:
Kennett, J.P. 1982: Marine geology. Prentice Hall.ISBN: 0135569362 9780135569368
Seibold, E. and Berger, W.H. 1982: The sea floor. Springer Verlag. ISBN 10: 0387568840.
Pipkin, B.W., Gorsline, D.S., Casey, R.E. and Hammond, D.E. 1972: Laboratory exercises in oceanography. Freeman.ISBN 10: 0716737426.
Introduction to physical Oceanography: John A.Knauss. ISBN-10: 1577664299, Orange grove Books.
The sea floor: An introduction to marine geology: M.J. Keen. ISBN: 9780080125053.
Marine geology: Exploring the new Frontiers of the ocean (the living earth) ISBN-10 0816050775.

SEMESTER VIII

MJ-20

Course Title : Geology of Northeast India

Theory Credits: 3

UNIT - I

Stratigraphic succession, lithology, structure, tectonics and mineral resources of Assam.
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Meghalaya.

UNIT - II

Stratigraphic succession, lithology, structure, tectonics and mineral resources of Arunachal Himalayas and Manipur.

UNIT - III

Stratigraphic succession, lithology, structure, tectonics and mineral resources of Mizoram and Tripura.

UNIT-IV

Practical Credit: 1

Megascopic studies on rocks and minerals in North East India.
Preparation of maps on minerals, tectonics and geomorphology.

Recommended Books and References:

Nandy, D.R. 2001: Geodynamics of Northeastern India and the adjoining region. ACB Publications.
Kumar. G. 1997: Geology of Arunachal Pradesh. Geol. Soc. India Publication.
Karunakaran, C. 1972: Geology and Mineral Resources of the states of India. Misc. Publ., GSI, vol. 30.
Dasgupta, A.B. and Biswas, A.K. 2000: Geology of Assam. Geol Soc. India Publication.
Naqvi, S.M. 2005: Geology and evolution of the Indian Plate (4 Ga to 4 Ka). Capital Publishing Co.
Krishnan, M.S. 1982: Geology of India and Burma (6th ed). CBS Publishers and Distributors, Delhi.
Kumar, R. 1985: Fundamental of historical geology and stratigraphy of India (3rd ed) Wiley Eastern.
Wadia, D.N. 1957: Geology of India (3rd ed).

MJ-21

Ore Geology & Mining

Theory Credits: 3

UNIT-I

Modern concept of ore genesis. Mode of occurrence of ore bodies - morphology and relationship of host rocks. Textures, paragenesis and zoning of ores and their significance. Concept of ore bearing fluids, their origin and migration; wall rock alteration. Organic matter in ores and their significance.

UNIT- II

Orthomagmatic ores of mafic-ultramafic association - diamonds in kimberlite, REE in carbonatites. Ores of silicic igneous rocks - Kiruna type, pegmatites. Stratiform and stratabound ore deposits, placers and palaeoplacers. Metamorphism of ores and metamorphogenic ores.

UNIT- III

Mining strategies: Planning, exploration and exploratory mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross-cutting, winzing, stoping, room and pillaring, top-slicing, sub-level caving and block caving. Mining hazards: mine inundation, fire and rock burst.

UNIT-IV

Practical Credit: 1

Megascopic identification of Indian metallic ores in handspecimen, megascopic study of structures and fabric of different ores and their associations, microscopic properties of ore forming minerals.

Books Recommended:

Craig, J.M. and Vaughan, D.J. 1981: Ore petrography and mineralogy. John Wiley.ISBN 0-471-55175-9.

Evans, A.M. 1993: Ore geology and industrial minerals. Blackwell.ISBN 9780632029532.

Sawkins, F.J. 1984: Metal deposits in relation to plate tectonics. Springer Verlag.ISBN 9783642967856.

Stanton, R.L. 1972: Ore petrology. McGraw Hill.ISBN. 0070608431.

Torling, D.H. 1981: Economic geology and geotectonics. Blackwell.ISBN-10: 0470271450.

Barnes, H.L. 1979: Geochemistry of hydrothermal ore deposits. John Wiley. ISBN 0471 050563.

Klemm, D.D. and Schneider, H.J. 1977: Time and strata bound ore deposits. Springer Verlag.ISBN 978364266806-7.

Guilbert, J.M. and Park, C.F. (Jr) 1986: The geology of ore deposits. Freeman. ISBN 10: 0716714566.
Mookherjee, A. 2000: Ore genesis - A holistic approach. Allied Publishers. ISBN 10: 8170235766.
Alan M. Bateman; Mead L. Jensen, Economic Mineral Deposits published by Wiley & Sons, Incorporated, John ISBN 10: 0471090433 ISBN 13: 9780471090434.
Anthony M. Evans, Ore Geology and Industrial Minerals: An Introduction (Geoscience Texts)Wiley (1993)ISBN 10: 0632029536 ISBN 13: 9780632029532.
Guilbert J.M. The Geology Of Ore Deposits (Pb 201*5).*Cbs (2015)ISBN 10: 8123925662 ISBN 13: 9788123925660.
Laurence R. Introduction to Ore-Forming Processes. Wiley-Blackwell. ISBN: 9780632063789.
Sarkar S.C. Gupta A Crustal Evolution and Metallogeny in India. Cambridge University Press; 1 editionISBN-13: 9781107007154 ISBN-10: 1107007151.

MJ-22

GEODYNAMICS & TECTONIC GEOMORPHOLOGY

Theory Credits: 3

UNIT -I

Phase transitions and seismic discontinuities in the earth. Mechanism of plate motion (mantle drag mechanism and edge force mechanism). Major tectonic features of the oceanic and continental crust. Rock magnetism and its origin; Paleomagnetism; magnetic and gravity anomalies at MOR, trenches, continental shield and mountain chains. Polarity reversals and supercontinental cycles.

UNIT-II

Orogeny, geodynamic evolution of Indian cratons (Dharwar, Singhbhum, Bastar, Bundelkhand and Marwar) and mobile belts (Eastern Ghat, Satpura and Aravalli-Delhi). Structure and origin of the Himalaya. Neotectonic movement, concept and evidence.

UNIT-III

Morphometric analysis: mountain-front sinuosity, hypsometric curve and integral, stream length gradient index, valley-floor width to valley height ratio, basin elongation, circulatory ratio, drainage basin asymmetry.

Tectonic modifications of alluvial and bedrock channel drivers: longitudinal profile, sinuosity, drainage pattern and drainage anomalies.

UNIT-IV

Practical Credit: 1

Preparation and interpretation of geological maps and sections. Study of map projections. Structural problems concerning economic mineral deposits. Recording and plotting of field data. Plotting and interpretation of petrofabric data and resultant diagrams. Study of large scale tectonic features of the earth. Drainage patterns and analysis.

Books Recommended:

Keary, P., Klepeis, K.A and Vine, F.J. 2009: Global Tectonics (3rd ed). Blackwell. ISBN: 9788126532957

Keary, P. and Vine, F.J. 1990: Global Tectonics. Blackwell.

Moores, E. and Twiss, R.J. 1995: Tectonics. Freeman.

Passchier, C.W. and Trouw, R.A.J. 2005: Microtectonics (2nd ed). Springer Verlag.

Suppe, J. 1985: Principles of Structural Geology. Prentice Hall.

Twiss, R.J and Moores, E.M. 2007: Structural Geology (2nd ed), Freeman.

Valdiya, K.S. 1998: Dynamic Himalaya. University Press, Hyderabad.

Edwards J.Plate Tectonics and Continental Drift, Published by Creative Co. ISBN 10: 1583407308 ISBN 13: 9781583407301
Keary P. Klepels K.A and Nive F.J. Global Tectonic, Wiley & Sons, Incorporated, John ISBN 10: 0865429243 ISBN 13: 9780865429246
Valdiya. K.S, Aspects of Tectonics. McGraw-Hill Education (1 October 1985) ISBN-10: 0074519727: ISBN-13: 978-0074519721
Valdiya. K.S. Making of India, Springer (2015) ISBN 10: 3319250272 ISBN 13: 9783319250274.

MJ-23
OPTICAL MINERALOGY & GEMOLOGY
Theory Credits: 3

UNIT- I

Nature of light, interaction of light and matter. Index of refraction, isotropic and anisotropic media, polarized light. Optic sign of isotropic and anisotropic minerals. Uniaxial optics, optic sign and interference figures. Biaxial optics, use of the indicatrix and interference figures. Optic sign and determination of the 2V angles.

UNIT- II

Introduction to the world of gemstones. Origin and structure of gemstones. Grading parameters of gemstones. Interconnection of beauty, rarity and durability and its effects on valuation. Physical properties: Hardness detection, methods of scratch test, difference between hardness and toughness, cleavage, fracture, specific gravity and others.

UNIT-III

Semi-precious stones, organic gemstones, unique system to identify the origin of precious stones. Sourcing gemstones. Identification of natural gemstones (rough and polished) from its simulants and synthetics. Shapes and cuts of gemstones. Terminology and nomenclature of gemstones (Indian and International markets). Uses of gemstone.

UNIT-IV
Practical Credit: 1

Microscopic study of common minerals.
Identification of optical properties: color, valuation, transparency, lustre.
Identification of gemstones: handspecimens and photographs.

Books Recommended:

1. Phillips, W.R. and Griffin, D.T. 1986: Optical mineralogy. CBS Publishers. ISBN, 9788123910642

2. Hutchinson, C.S. 1974: Laboratory handbook of petrographic techniques. John Wiley. ISBN-10: 0471425508; ISBN-13: 978-0471425502.

3. Peter G. Read, Gemmology Third Edition, April 2008, ISBN-10-0719803616

4. Walter Schumann, Gemstones of the world, Sterling Publishers, ISBN: -10-9780719803017

SE-MESTER	COURSE	COURSE NAME	COURSE CODE	CREDIT
I	MN-1	Essentials of Geology (Theory)		3
		Essentials of Geology (Practical)		1
II	MN-2	Crystallography & Mineralogy (Theory)		3
		Crystallography & Mineralogy (Practical)		1
III	MN-3	Structural Geology & Geomorphology (Theory)		3
		Structural Geology & Geomorphology (Practical)		1
IV	MN-4	Fundamentals of Petrology (Theory)		3
		Fundamentals of Petrology (Practical)		1
V	MN-5	Fossils and Their Application(Theory)		3
		Fossils and Their Application (Practical)		1
VI	MN-6	Geology Of Nagaland (Theory)		3
		Field work I- Basic Field Training		1
VII	MN-7	Earth Resources (Theory)		3
		Earth Resources (Practical)		1
VIII	MN-8	Natural Hazards and Disaster Management (Theory)		3
		Natural Hazards and Disaster Management (Practical)		1
			TOTAL	**32**

SEMESTER – I
MN – 1
ESSENTIALS OF GEOLOGY
Theory Credits: 3

UNIT I
Introduction to various branches of Geology.
Earth in the solar system: origin, size, shape, mass, density, rotational and revolutional parameters.
Structure of the earth.
Formation of core, mantle, crust atmosphere, hydrosphere and biosphere.
Terrestrial and Jovian planets.

UNIT II
Convection in the earth's core and production of magnetic field.
Concept of Plate tectonics: Continental drift and Seafloor spreading.
Mid-oceanic ridges, Trenches, Magmatic arcs, Transform faults.
Concept of Isostasy.
Earthquakes and Seismic waves.
Volcanoes: Types, products and their distribution.

UNIT III
Nature of stratigraphic records: Law of Superposition, Law of Original Horizontality, Law of Lateral Continuity, Law of Faunal Succession.
Nature of Cross-cutting relationships and Stratigraphic Contacts: Vertical, Horizontal, Intrusive.
Unconformities and Types.
Uniformitarianism, Catastrophism, Plutonism and Neptunism.
Basic concepts of Lithostratigraphy, Biostratigraphy, and Geochronology.
Chronostratigraphy and the Geological time scale.

UNIT IV
Practical Credit: 1

Study of major geomorphic features and their relationships with outcrops through physiographic models.
Study of distribution of major lithostratigraphic units on the map of India
Study of major ocean currents of the World
Problems on plate tectonics

SUGGESTED READINGS:
Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor &
Francis.
Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.
Gross, M. G. (1977). Oceanography: A view of the earth

SEMESTER – II
MN - 2
CRYSTALLOGRAPHY & MINERALOGY
Theory Credits: 3

UNIT-I
Elementary ideas about crystal morphology in relation to internal structures.
Crystal parameters and indices
Crystal symmetry
Study of normal classes of the Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic systems.

UNIT-II
Minerals –Definition, classification and physical properties.
Silicate structures.
Study of common rock forming minerals – Silica, Feldspar, Olivine, Pyroxene, Amphibole, Mica, Aluminosilicate and Garnet family.

UNIT-III
Isomorphism, Polymorphism and Pseudomorphism
Introduction to petrological microscope
Isotropic and anisotropic minerals
Refractive index, birefringence, pleochroism, interference colour, extinction and twinning.

UNIT-IV
Practical Credit: 1
1. Observation and documentation on symmetry of crystals
2. Study of physical properties of minerals in hand specimen
3. Silicates: Olivine, Garnet, Andalusite, SilIimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite
4. Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal. Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
5. Study of some key silicate minerals under optical microscope and their characteristic properties

Recommended Books and References:
1. Klein, C., Dutrow, B., Dwight, J., & Klein, The 23rd Edition of the Manual of MineralScience
(after James D. Dana). J. Wiley & Sons. 225
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-formingminerals
(Vol. 696). London: Longman.

SEMESTER – III
MN-3
STRUCTURAL GEOLOGY & GEOMORPHOLOGY
Theory Credit: 3

UNIT I

Orientation of planes and lines in space: dip, strike, rake and plunge. Concept of Contour lines. Topographic and structural maps: important representative factors of the map. Concept of rock deformation: Stress and Strain in rocks. Planar and linear structures.

UNIT II
Morphology and types of folds, faults and joints. Unconformity: formation and types.

UNIT III

Introduction to Geomorphology, Endogenic and Exogenic processes.
Drainage pattern and its types. Large scale mountain ranges (with emphasis on Himalaya).
Processes and landforms of fluvial, Aeolian and glacial.
Overview of Indian Geomorphology.

UNIT IV
Practical Credit: 1
1. Basic idea of topographic contours, Topographic sheets of various scales.
2. Introduction to Geological maps: Lithological and Structural maps
3. Structural contouring and 3-point problems of dip and strike
4. Drawing profile sections and interpretation of geological maps of different complexities
5. Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)
6. Reading topographic maps: Concept of scale, Preparation of a topographic profile.
7. Preparation of longitudinal profile of a river
8. Preparation of geomorphic maps; Interpretation of geomorphic processes from the geomorphology of the area.

Recommended Books and References:
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. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
7. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.
8. W.D.Thornburry: Principles of Geomorphology.
9. Richard John Huggett: Fundamentals of Geomorphology

SEMESTER IV
MN-4
FUNDAMENTALS OF PETROLOGY
Theory Credit: 3

UNIT I IGNEOUS PETROLOGY

Rock cycle. Igneous Rocks: Nature and Origin of magma.
Geothermal gradient. Mode of Occurrence of Igneous Rocks: Concordant and discordant bodies. Classification of Igneous Rocks. Textures and structures of igneous rocks.

UNIT II SEDIMENTARY PETROLOGY

Origin of Sediments: Weathering, Erosion, Transportation and Deposition.
Textures, grain size and particle shape. Classification of Sedimentary Rocks: Argillaceous, Arenaceous, Rudaceous, Clastic and Non-Clastic. Sedimentary structures.

UNIT III METAMORPHIC PETROLOGY

Metamorphism: Definition, Factors Controlling Metamorphism.
Types of metamorphism- contact, regional, burial, fault zone metamorphism, impact metamorphism.
Textures and structures of metamorphic rocks. Metamorphic facies.

UNIT IV
Practical Credit: 1

Megascopic study of igneous, sedimentary and metamorphic rock hand specimens.

SEMESTER V
MN-5
FOSSILS AND THEIR APPLICATION
Theory Credit: 3

UNIT I
Fossil: Definition, Types, modes of fossil preservation, uses of fossils. Binomial nomenclature. Taphonomy. Ichnology. Introduction to Gondwana Flora.

UNIT II
Morphological study and geological distribution of the following: Brachiopoda, bivalves, gastropoda and echinoida. Evolution of humans.

UNIT III
Application of Fossils in stratigraphy: Biozones, index fossils and correlation. Application of fossils in the study of paleoecology, paleobiogeography and paleoclimate. Microfossils.

UNIT IV
Practical Credit: 1

1. Study of important fossil groups.
2. Biostratigraphic correlation

Recommended Books and References:
1. Schoch, R.M. 1989. Stratigraphy, Principles and Methods. VanNostrand Reinhold.
2. Clarkson, E.N.K.1998. Invertebrate Paleontology and Evolution George AlIen & Unwin
3. Prothero, D.R. 1998. Bringing fossils to life - An introduction to Paleobiology, McGraw Hill.
4. Benton, M.J. 2005. Vertebrate paleontology (3rd edition). Blackwell Scientific, Oxford.
5. Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time, Edwin H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

SEMESTER VI
MN-6
GEOLOGY OF NAGALAND AND BASIC FIELD MAPPING
Theory Credit: 3

Unit-I

Introduction to geology of Nagaland: History, Physiography, stratigraphy and tectonic setting.

Unit-II

Schuppen Belt and Inner Fold Belt: Structure and lithounits. Ophiolite Belt and Naga Metamorphics: Structure, lithounits and tectonic setting.

Unit-III

Mineral resources of Nagaland: Coal, petroleum, limestone, metalliferous deposits and dimensional stones.

Unit-IV

Practical: Basic Field Training

SEMESTER- VII
MN-7
EARTH RESOURCES
Theory Credit: 3

UNIT I

Metallic and non-metallic mineral deposits.
Chemical composition, occurrence, origin, uses and distribution of the following economic mineral deposits in India: iron, manganese, chromium, copper, gold, limestone and clay.

UNIT II
Potential of Hydroelectric power, Geothermal, Solar Energy, Wind, Wave, Tidal and Biomass energy.
Groundwater resources and its role in economic development of a country.

UNIT III
Origin, occurrence, types, distribution and its applications: Natural oil and gas, coal and Nuclear Minerals.

UNIT IV
Practical Credit: 1

1. Plotting of major Indian oil fields on map of India
2. Problems on hydroelectric power generation
3. Problems on bio fuel
4. Problems on metallic and non-metallic mineral deposits
5. Problems on nuclear minerals

Recommended Books and References:
1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill ISBN: ISBN-0-07-021722-X
2. Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K.Ghosh and M. A. Prelas. 2009, Springer ISBN-10-9048184940

SEMESTER VIII
MN-8
NATURAL HAZARDS AND DISASTER MANAGEMENT
Theory Credit: 3

UNIT I
Introduction to natural hazards and disaster management.
Risk, Vulnerability and Hazard. Pre-disaster risk & vulnerability reduction, Post disaster recovery & rehabilitation
Prevention and rehabilitation: Emergency alert System Atmospheric Hazards, Hydrosphere and Related Hazards

UNIT II
Types of natural disaster: Cyclone, flood and Tsunami, landslide, subsidence, earthquake and volcanic eruption.

UNIT III
Climate change, heat wave, wildfire, droughts and associated hazards.
Disaster related infrastructure development.
Case study: Bhopal Gas leak disaster, Chernobyl nuclear disaster and Tsunami of 26th December 2004.

UNIT IV
Practical Credit: 1

Trainings in first aid, relief, rescue and mock drill.
The course will also include discussions on topics assigned to students based on their interest.

Recommended Books and References:
1. Bell, F.G., 1999. Geological Hazards, Routledge, London.
2. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
3. Smith, K., 1992. Environmental Hazards. Routledge, London.
4. Subramaniam, V., 2001. Textbook in Environmental Science, Narosa International

Skill Enhancement Course

SEC-1

Course name: Water Quality Analysis

Unit-I

Theory- Credit-1

Characteristics of water, physical and chemical properties of water, chemical, physical and biological analysis of water. Water quality for drinking and irrigation purpose. Water sampling procedure methods, graphical representation, water quality index.

Unit-II

Practical- Credits-1

Physical parameter analysis (pH, TDS, EC, BOD, temperature)

Chemical parameter analysis

Alkalinity, Salinity, hardness, Bicarbonate, calcium, magnesium, chloride, sodium, potassium, fluoride.

Unit-III

Practical- Credits-1

Graphical representation of chemical parameter (Piper diagram, stiff diagram, scatter diagram).

Interpretation of water quality (Hardness classification, salinity (TDS) classification), Water quality index. Sodium percent and Sodium Absorption Ratio.

References:

1. Keith David, Todd (1980) Groundwater Hydrology, John Wiley & Sons.
2. Sharma, B.K (2001) Water Pollution, Goel Publishing house, Meerut.
3. Stanley N Davis, Roger J.M Weist (1989) Hydrogeology
4. Khan Saimah & Khan Rahman Abdul, 2023, Water quality analysis and treatment.
5. Guidelines for drinking water quality, WHO, 2022.
6. Indian Standard Drinking Water- Specification, 2008.

SEC- 2

Course name: Basic English Communication Skills

Theory & Practical: Credits-3

Unit-I:

Introduction to communicative english and grammar
Notion of correctness and attitude to error correction
Importance of listening skills
Problems of listening to unfamiliar dialects

Unit-II:

Aspects of pronunciation and fluency in speaking
Intelligibility in speaking
Introduction to reading skills
Introducing different types of texts–narrative, descriptive, extrapolative

Unit-III:

Introduction to writing skills
Aspects of cohesion and coherence
Expanding a given sentence without affecting the structure
Reorganizing jumbled sentences into a coherent paragraph
Drafting different types of letters (personal notes, notices, complaints, appreciation, conveying sympathies etc.)

Suggested Reading:

1. Acevedo and Gower M (1999) Reading and Writing Skills. London, Longman
2. Deuter, Met.al. (2015). Oxford Advanced Learner's Dictionary of English (Ninth Edition). New Delhi, OUP
3. Eastwood, John (2008). Oxford Practice Grammar. Oxford, OUP.
4. Editorial Board. (2012) Prosaic Musings-Nagaland University Anthology of Prose, Short Stories and Writing Skills. New Delhi: Trinity.
5. Editorial Board. (2012). Wings of Poesy: Nagaland University Anthology of Poetry. Macmillan/ Trinity.
6. Hadefield, Chris and J Hadefield (2008). Reading Games. London, Longman
7. Hedge, T (2005). Writing. Oxford, OUP 8. Jolly, David (1984). Writing Tasks: Students' Book. Cambridge, CUP
9. Klippel and Swan (1984). Keep Talking. Oxford, OUP
10. Saraswati, V (2005). Organized Writing 1. Hyderabad, Orient Blackswan
11. Swan, Michael. (1980). Practical English Usage. Oxford, OUP
12. Walter and Swan (1997). How English Works. Oxford, OUP

SEC-3

Course name: Geological Mapping Techniques

Unit -I
Theory- 1 credit

Basic function of Brunton Compass and Clinometer; Location determination taking front and back bearing from distant object. Determination of true dip and apparent dip and strike beds. Reading of topographic sheets.

Unit II & III
Practical-2 Credits

Identification and analysis of geological structures; faults, folds, joints, unconformities. Measurement of the attitude (dip and strike) of various geological structures.

Mapping of geological structures including faults, faults, unconformities.

Preparation of cross section profile from geological maps.

References

1. Mukherjee. P. K- A textbook of Geology
2. Mahapatra G.B- A textbook of geology
3. Singh Parbin- Engineering & General Geology

SEMESTER I

MULTI DISCIPLINARY COURSES (MD-1)

Fundamentals of Earth System Science

Theory credits: 2

Unit 1

Introduction to geology and its various branches.

Solar system: Terrestrial and Jovian planets.

Earth in the solar system-origin, size, shape, mass, density, rotational and revolution parameters. Age of the Earth.

Internal structure of the earth.

Earth's heat budget.

Unit 2

Concept of plate tectonics: Continental drift and sea floor spreading.

Types of plate boundaries: Convergent, Divergent and Transform

Atmosphere: Composition and structure

Unit 3

Practical Credit: 1

Study of Plate Tectonic models

Schematic representation on internal structure of the Earth

Indication of Plate boundaries on the map

Study of geological structures

Recommended books and references:

Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor & Francis.

Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.

Gross, M. G. (1977). Oceanography: A view of the earth

SEMESTER II
MULTI DISCIPLINARY COURSE (MD-2)
ROCKS AND MINERALS
Theory credits: 2

Unit 1
Minerals- Definition.
Common rock forming minerals: Quartz, Feldspar, Mica (Biotite and Muscovite), Olivine and Pyroxene.
Physical properties of minerals: Color, Lustre, Form, Hardness, fracture, streak, cleavage, specific gravity.

Unit 2
Igneous rocks: Origin and Classification
Sedimentary rocks: Origin and classification
Metamorphic rocks: Agents and types of metamorphism

Unit 3
Practical Credit: 1
Identification of Minerals in hand specimen.
Identification of Igneous rocks in hand specimen
Identification of Metamorphic rocks in hand specimen
Identification of Sedimentary rocks in hand specimen

Recommended Books and References:
1. 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 III
MULTI DISCIPLINARY COURSES (MD-3)
GEOLOGICAL HAZARDS
Theory credits: 2

Unit 1
Earthquakes: Definition and classification. Causes and kinds of seismic waves, Richter and Mercalli scale.
Volcanoes: Types (Continuity of eruption; Nature of eruption; Mode of eruption), products and their distribution

Unit2
Landslides: Causes, impacts and mitigation
Tsunami: Causes, impact and mitigation
Flood: Causes, impact and mitigation

Unit3
Practical Credit: 1
Study of seismic zonation map of India
Distribution of earthquake belts
Location of epicenter using triangulation method
Location of active volcanoes around the world

Recommended Books and References:
1. Bell, F.G., 1999. Geological Hazards, Routledge, London.
2. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
3. Smith, K., 1992. Environmental Hazards. Routledge, London.

VALUE ADDED COURSE (VAC)

VAC-2

Course name: Mineral Resources of Nagaland

Credits-3

Unit-1

Mineral resources of Nagaland with special reference to limestone and dimensional stones.

Unit-2

Mineral resources of Nagaland with special reference to coal and petroleum.

Unit-3

Metalliferous deposits of Nagaland- Chromium, Nickel and cobalt.

Recommended books and references:

1. Geology of India- D N Wadia, Tata McGraw Hill Publishing
2. Phanerozoic Ophiolites of India- P. C Ghose, Sunna Publishers and distributors.
3. Fundamentals of Historical Geology and Stratigraphy of India- Ravindra Kumar