

MIZORAM UNIVERSITY



MODIFIED SYLLABUS OF SIX SEMESTER DEGREE COURSE IN GEOLOGY (Core & Elective)

To Be Presented Before

**BOARD OF STUDIES IN GEOLOGY
Mizoram University
Aizawl, Mizoram
2014**

Semester	Paper Number	Title of the Paper	ELECTIVE / CORE	Marks Ext + Int = Total			
I	Geol- I	General & Structural Geology and Mineralogy	E L E C T I V E C O R E	Core or Elective	50+20	100	
	Geol- I Practical	General & Structural Geology and Mineralogy		Core or Elective	20+10		
II	Geol- II	Petrology & Geochemistry		Core or Elective	50+20	100	
	Geol- II Practical	Petrology & Geochemistry		Core or Elective	20+10		
III	Geol- III	Stratigraphy & Paleontology-I		Core or Elective	50+20	100	
	Geol- III Practical	Stratigraphy & Paleontology-I		Core or Elective	20+10		
IV	Geol- IV	Economic & Applied Geology		Core or Elective	50+20	100	
	Geol- IV Practical	Economic & Applied Geology		Core or Elective	20+10		
V	Geol- V	Applied & Engineering Geology		O R E	Core	50+20	100
	Geol- V Practical	Applied & Engineering Geology			Core	20+10	
	Geol- VI	Sedimentology			Core	50+20	100
	Geol- VI Practical	Sedimentology			Core	20+10	
	Geol- VII	Igneous & Metamorphic Petrology	Core		50+20	100	
	Geol- VII Practical	Igneous & Metamorphic Petrology	Core		20+10		
	Geol- VIII	Option-A: Hydrogeology, Oceanography & Environmental Geology Option-B: Geology of North East India	Core		50+20	100	
	Geol- VIII Practical	Option-A: Hydrogeology, Oceanography & Environmental Geology Option-B: Geology of North East India	Core		20+10		
VI	Geol- IX	Paleontology & Stratigraphy-II	R E	Core	50+20	100	
	Geol- IX Practical	Paleontology & Stratigraphy-II		Core	20+10		
	Geol- X	Economic Geology & Mineral Resources of India		Core	50+20	100	
	Geol- X Practical	Economic Geology & Mineral Resources of India		Core	20+10		
	Geol- XI	Dynamics of the Earth & Structural Geology		Core	50+20	100	
	Geol- XI Practical	Dynamics of the Earth & Structural Geology		Core	20+10		
	Geol- XII	Option-A: Fuel Geology & Mineral Exploration Option-B: Environmental Geology		Core	50+20	100	
	Geol- XII Practical	Option-A: Fuel Geology & Mineral Exploration Option-B: Environmental Geology		Core	20+10		

SEMESTER – I
PAPER – I: Core or Elective

GENERAL & STRUCTURAL GEOLOGY and MINERALOGY

(70 Marks)

Unit-I: PHYSICAL GEOLOGY

Introduction to geology, scope, sub disciplines and relationship with other branches of science; Internal constitution of the earth. Elementary ideas about Sea floor spreading, continental drift & Plate tectonics. Earthquakes & Volcanos - causes, geological effects, products and their measurement, distribution of earthquake belts. Theories of origin of Solar system: Nebular, Interstellar, Tidal, Planetesimal & Big Bang.

Unit-II: STRUCTURAL GEOLOGY

Topography and its representation; Dip and strike; Outcrop, Instruments used in the field study; Clinometers and Brunton compass and their use; Folds, parts of fold, geometric classification of folds and causes of folding. Faults - parts of faults, types of faults and causes of faulting; Joints- their geometric classification; Unconformity, its kinds and significance;

MINERALOGY & CRYSTALLOGRAPHY

Unit-III

Minerals, definition and classification; Silicate structure and description of common mineral groups: silica, feldspar, mica, olivine, pyroxene, amphibole and garnet. Common physical properties of minerals: quartz, plagioclase, orthoclase, microcline, garnet, biotite, muscovite, pyroxene, hornblende & olivine.

Unit-IV

Polarizing microscope, its parts and functioning; Common Optical properties: isotropism; nature of light; Uniaxial and Biaxial minerals, Optical properties of Common rock forming Minerals: quartz, plagioclase, orthoclase, microcline, garnet, biotite, muscovite, pyroxene, hornblende, olivine & tourmaline.

Unit-V

Fundamental laws of Crystallography. Elementary idea of crystal structure; Parts of crystal - face, edge, solid angle and interfacial angle, Common crystal forms - dome, prism, pyramid and pinacoid; Parameters and indices; Contact Goniometry, Elements of crystal symmetry;

Introduction to different crystals systems. Study of Normal (Holosymmetric) Class of each crystal system.

PRACTICALS (30 Marks)

Physical Geology:

Study of models of Internal structure of the earth, Earthquake, Volcano, Alluvial, Glacial & Marine.

Structural Geology:

Study of Brunton compass; Exercises on structural problems; Drawing Geological Sections and their interpretation and completion of outcrop.

Mineralogy and Crystallography

Study of elements of symmetry of representative crystals from each system; Use of polarizing microscope; Study of optical properties of important rock forming minerals.

BOOKS RECOMMENDED

- Billings, M.P. (1972): Structural Geology, Prentice Hall.
Dennis, J.G. (1972): Structural Geology, Ronald Press Company, New York.
Hills, E.S. (1963): Elements of Structural Geology, Farrold and Sons, London.
Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall, London.
Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III, Academic Press.
Ruhe, R.V. (1975): Geomorphology, Houghton Mifflin Co., Boston.
Singh, R. P. (1995): Structural Geology, A Practical Approach, Ganga Kaveri Publ., Varanasi.
Sparks (1960): Geomorphology, Longmans, London.
Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ..
Dana, E.S. and Ford, W.E.(2002): A textbook of Mineralogy (Reprints).
Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
Phillips, F.C (1971): Introduction to Crystallography, Longman Group Publ..
Read, H.H. (1968): Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murphy and Co.

SEMESTER – II

Paper – II: Core or Elective

PETROLOGY & GEOCHEMISTRY (70 Marks)

Unit-I: IGNEOUS PETROLOGY

Petrology- Definition & subdivisions; Definition, composition and types of Magma; Magmatic Differentiation and Assimilation; Bowen's Reaction Series; Forms of Igneous Rocks; Texture & Structure of Igneous Rocks; IUGS Classification of Igneous Rocks; Petrographic description of common igneous rocks (Granite, Diorite, Syenite, Gabbro, Dolerite, Basalt, Rhyolite, Trachyte, Pyroxenite and Peridotite)

Unit-II: SEDIMENTARY PETROLOGY

Weathering and denudation of supra-crustal rocks; Origin of clastic and nonclastic sediments and genesis of sedimentary rocks; Primary sedimentary structures; Elementary idea about texture and mineral composition of clastic and nonclastic sedimentary rocks; General classification of sedimentary rocks; Descriptive petrography of fundamental rock types such as - conglomerate, breccia, sandstone, limestone and shale.

Unit-III: METAMORPHIC PETROLOGY

Definition, types and agents of metamorphism; Metamorphic textures and structures; Zones of Metamorphism, Study of Common metamorphic rocks as given below: Slate, phyllite, schist, gneiss, hornfels, marble, quartzite. Elementary ideas about Metamorphic facies.

Unit-IV: GEOCHEMISTRY

Fundamentals of Geochemistry, Geochemical classification of elements. Cosmic Abundance of Elements, Types of Meteorites, Primary and Secondary Dispersion, Trace and Path Finder Elements, Clarke Value, Background Value and Treshhold Value. Principle of Diadocic replacement.

Unit-V: INTRODUCTION TO ANALYTICAL TECHNIQUES

Introduction to the important analytical methods. XRD (X Ray Diffraction Technique, SEM (Scanning Electron Microscope), XRF (X Ray Fluorescence Technique), ICP- MS (Inductively Coupled Plasma Technique). Electron Microprobe Analyses.

PRACTICALS (30 Marks)

Petrology

Megascopic and microscopic study of the following rock types:

Igneous: Granite, Syenite, Nepheline, Syenite, Diorite, Gabbro, Peridotite, Rhyolite, Trachyte, Dolerite, Basalt

Sedimentary: Sandstone, Shale, Limestone, Conglomerate, Breccias

Metamorphic: Gneiss, Schist, Quartzite, Marble

Geochemistry

Preparation of Isograd maps, Determination of enriched horizon through interpretation of geochemical field data.

Local Geological Field Work

BOOKS RECOMMENDED

Best, Myron G.(2002): Igneous and Metamorphic Petrology, Blackwell Science.

Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.

Brown, C. and Dey, A.K. (1955): Indian Mineral Wealth, Oxford Univ.

Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology, CBS Publ.

Huang: (1962): Petrology, McGraw Hill Book Co.

Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley and Sons.

Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.

Nockold, Knox and Chinner (1978): Petrology for students, Cambridge Univ. Press.

Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad Publ.

Winkler, H. G.F. (1967): Petrogenesis of Metamorphic Rocks, Springer-Verlag.

SEMESTER – III

Paper – III: Core or Elective

STRATIGRAPHY & PALEONTOLOGY-I

(70 Marks)

SECTION – A: PALEONTOLOGY

Unit-I

Paleontology, definition, subdivisions and scope, its relationship with other sub-disciplines of geology; History of development in paleontology; Fossils, definition, types (body and trace fossils); Modes of preservation of fossils; Incompleteness of fossils record; Elementary ideas about origin of life; their adaptation to various kinds of environments; Bathymetry, Systematic classification of organisms.

Unit-II

A detail study of morphology, geological distribution and paleoecology of class/order of – Trilobites, Graptoloidea, Corals, Echinoidea, Brachiopoda & Mollusca.

SECTION – B: STRATIGRAPHY

Unit-III

Stratigraphy: Definition, its scope and relationships with other subdisciplines of geology; Geological time scale; History of advancement in stratigraphy; Principles of stratigraphy; Elements of Dual Stratigraphic classification: Lithostratigraphic units, Bio stratigraphic units and Chronostratigraphic units and Litho-Chronostratigraphic units; Stratigraphic Correlation, Imperfections in geological records.

Unit-IV

Study of the important Indian Precambrian and Proterozoic geologic horizons with special reference to classification, lithology and economic significance - Dharwar of Karnataka, Indravati Group, Precambrians of Central India: Sausar Group, Precambrians of North East India: Shillong and Mikir massif, Cuddapah and Vindhyan supergroup.

Unit-V

Study of the Gondwana Supergroup and Deccan Traps with reference to classification, Lithology and economic significance.

Study of – Siwalik Group, Tertiary Stratigraphy of NE with special reference to classification, lithology and economic significance

PRACTICALS (30 Marks)

Paleontology

Study of fossils showing various modes of preservation. Labeling of important genera of phylum Brachiopoda and Mollusca.

Stratigraphy

Preparation of lithostratigraphic maps of India showing distribution of the following- Dharwar Supergroup, Precambrian of NE India, Cuddapah Supergroup and Vindhyan Supergroup, Gondwana Supergroup, Deccan Trap, Siwalik Group, Tertiary of NE India including Surma Basin.

Study of important rock types of the above mentioned stratigraphic units; Preparation of physiographic map of India showing important features.

BOOKS RECOMMENDED

- Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ.
Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and Animal Distribution, Vishal Publ.
Krishnan, M.S. (1968): Geology of India and Burma, Higginbotham, Madras.
Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997): Invertebrate Fossils, CBS Publ.
Nield, E.W. and Tucker, V.C.T. (1985): Palaeontology: An Introduction, Pergmon Press.
Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
Shrock, R.R. and Twenhoffel, W.H. (1952): Principles of Invertebrate Paleontology, CBS Publ.
Wadia, D.N. (1966): Geology of India, English language Publ.
Weller, J.M. (1960): Stratigraphic Principles and Practices, Universal Book.
Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.

SEMESTER - IV

Paper – IV: Core or Elective

ECONOMIC & APPLIED GEOLOGY

(70 Marks)

Unit – I: Economic Geology

Concept of ore, ore minerals and gangue in economic geology; Tenor of ores; Various process of formation of ore minerals. Classification of mineral deposits. Ore minerals in relation to plate tectonics.

Unit-II: Mining Geology

Introduction and scope of mining. Exploratory mining terminology : adit, tunnel, drift, inclined and vertical shaft, cross cuts, winse and raise. Duties of a geologist in a mining enterprise. Important Mining methods: surface mining methods–alluvial and open cast mining methods. Underground mining methods.

Unit-III: Exploration Geology

Principles and methods of important Geological exploration techniques

Basic ideas about Geophysical Exploration Techniques.

Basic ideas about Geochemical Exploration, Geochemical Sampling methods, Assay maps, Isograde map and Anomaly maps.

Basic ideas about Geobotanical exploration: Biological, Zoological, Geo-zoological indicators.

Unit-IV: Engineering Geology & Photogeology

Engineering properties of rocks, Geological Consideration for the construction of Dam, Tunnel and Bridge.

Elementary idea of Photo geology and Photo interpretation, Pocket Stereoscope, Mirror Stereoscope, Recognition elements in the study of aerial photos- tone, texture, pattern, shape, size, form, shadow, drainage, vegetation, and landforms. Basics of Remote Sensing.

Unit-V: Hydrogeology

Definition of hydrogeology; Hydrological cycle; Hydrological parameters - Precipitation, evaporation, transpiration and infiltration; Origin and age of groundwater; Vertical

distribution of groundwater; Types of aquifers; Forms of pollution in Ground Water. Elementary idea of Ground Water Exploration.

PRACTICALS (30 Marks)

Economic Geology

Identification and description of the following minerals in hand specimens by their physical properties - Graphite, malachite, chalcopyrite, pyrite, hematite, Magnetite, Ilmenite, Chromite, Pyrolusite, Psilomelane, Bauxite, Asbestos, Corundum, Coal Gypsum, Barite, Fluorite, Galena, Sphalerite, Kaoline, Sillimanite, Kyanite, Calcite, Azurite, Siderite, Magnesite, Rhodochrosite, Realgar, Orpiment, Stibnite, Molybdenite, Apatite, Pyrrhotite, Bornite, Arsenopyrite, Chrysolite, Cuprite, Limonite and Monazite; Preparation of maps showing distribution of important metallic and non-metallic deposits and important coal and oil fields of India.

Exploration Geology

Practical Exercises on interpretation of Geophysical field data.

Practical exercises on geochemical exploration data: Preparation of Isograd maps, Iso-ash contours, Assay maps.

Determination of enriched horizon through interpretation of geochemical field data.

Engineering & Remote Sensing

Slope Analysis from Topographical Maps; Interpretation of Ariel Photographs; Working with Stereoscopes,

Topographical survey with the help of chain and plane table. Application of GIS software's in geological mapping. Working with GIS software's.

Hydrogeology

Preparation of water table contour map and their interpretation; Graphical representation and interpretation of water quality data; Exercises on the geophysical methods of Ground Water prospecting. Preparation of flood zonation maps of India.

Local Geological Field Work

BOOKS RECOMMENDED

- Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, JohnWiley.
Miller, Victor, C. 1961. Photogeology. McGraw Hill Book Co., New York.
Gupta R.P. 2003. Remote Sensing Geology. 2nd Ed., Springer-Verlag,Heidelberg, Germany.
Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.

Parbin Singh: Engineering & General Geology, SK Kataria & Sons, New Delhi

Davies, S. N. and De Wiest, R. J. N. (1966): Hydrogeology, John Wiley and Sons.

Dobrin, M. B., and Savit, C. H., (1988): Introduction to Geophysical Prospecting, McGraw-Hill Book Co.

Karant, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.

Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.

Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.

Brown, C. and Dey, A.K. (1955): Indian Mineral Wealth, Oxford Univ.

Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology, CBS Publ.

Huang: (1962): Petrology, McGraw Hill Book Co.

Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley and Sons.

Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.

Nockold, Knox and Chinner (1978): Petrology for students, Cambridge Univ. Press.

Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad Publ.

Winkler, H. G.F. (1967): Petrogenesis of Metamorphic Rocks, Springer-Verlag.

SEMESTER – V

Paper – V: Core

APPLIED & ENGINEERING GEOLOGY (70 Marks)

Unit: I- ENGINEERING GEOLOGY

Geological Consideration for the construction of Reservoir, Tunnel and Highways. Construction and Building Material and their Engineering properties. Specification of construction, building and industrial materials. Role of Geologists in Engineering projects.

Unit: II- SURVEYING & FIELD GEOLOGY

Reading of Topographic sheets. Reconnaissance Geological Traverse, Actual Geological Mapping, Brunton compass, Taking front and back bearing from distant objects. Measurement of pitch and plunge.

Calculation of True dip and apparent dip. Determination of Throw/Heave/Stratigraphic separation. Strain analysis of deformed oriented rocks. Elementary structural analysis with use of stereographic methods - Interpretation of Geological and contour maps.

REMOTE SENSING & GIS

Unit: III

Basic principles of Remote Sensing. Electromagnetic spectrum. Remote Sensing Platform: Basic idea about platforms & Sensors. Basic idea of Radar Image. Orbit of satellite- Geosynchronous orbit, Sun synchronous orbit, Geostationary. Remote sensing Satellites with a special reference to LANDSAT, SPOT, IRS Series.

Unit-IV

Principles of Geographic Information System (GIS). Application of GIS in Earth Science: Mineral Exploration, Plate Tectonics, Global Warming, Environmental Pollution, Urban Planning, Disaster Management.

Unit: V- PALAEO-MAGNETISM

Introduction to Geomagnetism and Magnetic Field of the Earth. Palaeomagnetism-Principles, methods and applications. Magnetic Survey. Polarity reversals, and polarity reversal scales. Polar wandering; Basic idea about Magnetostratigraphy. Continental reconstruction; Elementary ideas on magmatism in oceanic ridges and subduction zone.

PRACTICALS (30 Marks)

Slope Analysis from Topographical Maps; Interpretation of Ariel Photographs; Working with Stereoscopes, Topographical survey with the help of chain and plane table. Application of GIS software's in geological mapping.

Calculation Intensity of magnetism, preparation of lithologs for magnetostratigraphy.

BOOKS RECOMMENDED

- Banger, K. M. (2009): Principals of Engineering Geology, Standard Publishers
Singh Parbin (2012): Engineering and General Geology, S. K. Kataria and Sons Publishers
Punmia, B. C. (2005): Surveying (Volume – 1&2), Laxmi Publication Ltd.
Lahee, F.H. (2005): Field Geology, 6th Edition, CBS Publishers & Distributors
Gokhale, N.W. (2011): A Guide to Field Geology, CBS Publishers & Distributors
Coe, Angela L. (2010): Geological Field Techniques, A John Wiley & Sons, Ltd.
Kong, Jin Au. (2006): Introduction to the Physics and Techniques of Remote Sensing, 2nd Edition, A John Wiley & Sons, Inc.
Bhatta, B. (2008): Remote Sensing and GIS, Oxford University Press
Chipman, L.K. (2011): Remote Sensing and Image Interpretation, Wiley India Pvt Ltd
Merrill, Ronald T., (1996):The Magnetic Field of the Earth: Paleomagnetism, the Core, and the Deep Mantle, Academic Press
McElhinny, Michael W., (2000): Paleomagnetism Continents and Oceans, Academic Press

SEMESTER – V

PAPER –VI: Core SEDIMENTOLOGY (70 Marks)

Unit-I

Various processes of formation of sedimentary rocks-weathering, transportation, deposition, various stages of diagenesis; Types of Fluids, Laminar and Turbulent Flow. Texture of sedimentary rocks.

Unit-II

Structures of sedimentary rocks. Classification of sedimentary rocks: based on composition (siliciclastic, limestone, chert etc.), based on source (terrigenous-extrabasinal, chemogenic-intrabasinal), based on grain size (conglomerate, rudaceous, sandstone-arenaceous, shale-argillaceous, calcarenite, calcareous sandstone, micrite), based on mode of deposition (clastic-terrigenous-allochemical, non-clastic-orthochemical).

Unit-III

Provenance- Definition and concepts; Heavy minerals and their significance.

Depositional environments- eolian, fluvial and marine environments.

Unit-IV

Definition, composition, classification, petrogenesis of Sandstone, Shale, Limestone & Dolomite; Sandstone classification - Pettijohn, Folk; Limestone classification - Dunham, Folk.

Sequence Stratigraphy

Unit-V

Tectonics and Sedimentation. Facies concept: Definition of facies; Basic concept of facies association- molasse and flysch facies

Introduction to Sequence Stratigraphy: sequence, system tract, parasequence, sequence boundary, lowstand, transgressive, and highstand systems tracts.

PRACTICALS (30 Marks)

Sedimentary Petrology

Megascopic and microscopic examination of conglomerate, breccia, quartz arenite, arkose, lithic arenite, quartzwacke, feldspathicwacke, lithicwacke (grewacke), mudrocks/shale and limestone. Plotting of grain-size parameter on triangular graph.

BOOKS RECOMMENDED

- Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer-Verlag.
- Ehler, E.G. and Blatt, H. (1982): Igneous, Sedimentary and Metamorphic Petrology, CBS Publ.
- Greensmith, J. T. (1984): Petrology of Sedimentary rocks, Thomas Murphy Publ.
- Hatch, F.H., Rastall, R.H. and Black, M. : Petrology of Sedimentary Rocks, Thomas Murphy Publ.
- Mason, R. (1978): Petrology of Metamorphic Rocks, CBS Publ.
- Pettijohn, F.J. (1957): Sedimentary rocks (3rd Ed.), Oxford Book Co.
- Winkler, H.G.C. (1967): Petrogenesis of Metamorphic Rocks, Narosa Publ.
- Yardley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

**SEMESTER V
PAPER VII: CORE**

**IGNEOUS & METAMORPHIC PETROLOGY
(70 Marks)**

Section-A: IGNEOUS PETROLOGY

UNIT-I

Classification of Igneous rocks: IUGS, CIPW, Niggli, Alkali Lime Index. Composition, texture, occurrence and distribution of the following igneous rocks: Granite, Syenite, Diorite, Gabbro, Dunite, Pegmatite, Dolerite, Rhyolite, Pumice, Basalt, Trachyte, Andesite.

UNIT -II

Definition, composition and types of Magma; Genesis of magma, Bowen's Reaction Series; Magmatic differentiation and assimilation; Concepts of rock series and rock association; Phase rule: system, phase and components, Mixed Crystal and their petrological significance.

UNIT -III

Phase relationships of the following Binary and Ternary Systems and their Petrogenesis: (i) Albite-Anorthite; (ii) Nepheline-Silica; (iii) Forsterite-Silica; (iv) Diopside-Anorthite-Albite. Descriptive petrography and petrogenesis of following rocks/rock families; (i) Granite-Rhyolite Family; (ii) Syenite-Trachyte Family (iii) Gabbros-Basalt Family; (iv) Ultra basic rocks; and (v) Anorthite, Alkaline rocks; Carbonatite, Pyroxenite, Lamprophyre & Ophiolites;

Section-B: METAMORPHIC PETROLOGY

UNIT -IV

Metamorphic zones and isograds; Progressive, regional and thermal metamorphism of pelitic, calcareous and basic igneous rocks

Concept of Metamorphic Facies. Characteristic PT conditions and mineral assemblages in different facies.

Anatexis, Metasomatism, Pneumatolysis. Prograde, retrograde and polymetamorphism.

Study of Common metamorphic rocks as given below: Slate, phyllite, schist, gneiss, hornfels, marble, quartzite.

UNIT -V

Graphical representation of mineral assemblages in ACF, AKF, AFM diagrams;

Phase rule and Goldschmidt's mineralogical phase rule; Principles of metamorphic reactions, metamorphic facies and metamorphic facies series;

Petrography and petrogenesis of following rocks:- Eclogite, Granulite, Khondalites, Gondites and Migmatites.

PRACTICALS (30 Marks)

Igneous Petrology

Megascopic and microscopic study of the igneous rocks as per list given in the theory paper.

Metamorphic Rocks

Megascopic and microscopic study of metamorphic rocks - slate, phyllite, schist, gneiss, marble, quartzite, hornfels, khondalite

BOOKS RECOMMENDED

Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer-Verlag.

Ehler, E.G. and Blatt, H. (1982): Igneous, Sedimentary and Metamorphic Petrology, CBS Publ.

Greensmith, J. T. (1984): Petrology of Sedimentary rocks, Thomas Murphy Publ.

Hatch, F.H., Rastall, R.H. and Black, M. : Petrology of Sedimentary Rocks, Thomas Murphy Publ.

Mason, R. (1978): Petrology of Metamorphic Rocks, CBS Publ.

Pettijohn, F.J. (1957): Sedimentary rocks (3rd Ed.), Oxford Book Co.

Winkler, H.G.C. (1967): Petrogenesis of Metamorphic Rocks, Narosa Publ.

Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

SEMESTER V

PAPER VIII: Core

Option-A: HYDROGEOLOGY, OCEANOGRAPHY & ENVIRONMENTAL GEOLOGY

(70 Marks)

Unit-I

Hydrological parameters - Precipitation, evaporation, transpiration and infiltration; Water bearing properties of rocks - Porosity and Permeability; Retention of water in rocks and yield of water from rocks; Vertical distribution of groundwater; Types of aquifers; Different types of springs and their formations; Darcy's law and its validity.

Unit-II

Elementary idea of Ground Water Exploration: Geophysical groundwater prospecting, Application of Remote Sensing in Ground Water resources. Instrumentation in Hydrology: Rain gauging, Snow Gauging & Hydrographs. Forms of pollution in Ground Water. Dissolved constituent of groundwater;

Unit-III

Salinization of groundwater; ISI and WHO standards for drinking, irrigation and industrial quality - Treatment methods for improving quality. Methods of water collection and preparation for of samples for analysis. Water balance – recharge and discharge. Basic concepts of rainwater harvesting and artificial recharge.

Water resources in India, Important drainage systems in India with special reference to NE India.

Unit-IV

Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, Currents of Indian, Atlantic and Pacific Oceans Thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans.

Unit-V

Definition and concept of Environmental Geology. Degradation of our environment, Toxicity, Residence time, Impact of man on environment. Natural hazards – earthquake, volcanic eruption, landslides, floods, and droughts, coastal erosion and their impact on environment. Water pollution: Causes, sources and effects of water pollution on human health. Soil: types, degradation and mitigation, soil pollution. Impact of mining on Environment.

PRACTICALS (30 Marks)

Exercises on the plotting of Ocean Currents on the world outline map

Exercises on Hydrological maps.

Interpretation of Environmental impact from field data provided.

Exercise on location of Epicenter of an Earthquake.

Hazard zonation map of India.

Field visit to landslide affected areas.

BOOKS RECOMMENDED

- Todd, D.K., (2005): Groundwater Hydrology, 3rd Edition, John Wiley & Sons
Fetter, C.W., (2009): Applied Hydrology, 4th Edition, Prentice Hall
Raghunath, H.M. (2006): Hydrology: Principles, Analysis, Design, 2nd Edition, New Age International (P) Ltd.
Trujillo, Alan P. (2011): Essentials of Oceanography, 10th Edition, Prentice Hall
Garrison, Tom (2009): Essentials of Oceanography, 5th Edition, Brooks/Cole
Barale, Vittorio (2010): Oceanography from Space, 1st Edition, Springer
Keller Edward A., (2013): Environmental Geology, 9th Edition, Prentice Hall
Reichard James S., (2011): Environmental Geology, 1st Edition, McGraw Hills
Montgomery Carla W., (2011): Environmental Geology, 9th Edition

SEMESTER V

PAPER VIII: CORE

Option-B: GEOLOGY OF NORTH EAST INDIA (70 Marks)

UNIT -I

Geographical Setup of North East India; Geotectonic Setup of North East India.
Morphotectonic set up of different tectonic domains.

UNIT -II

Seismotectonics of Indo Myanmar (Burmese) Mobile Belt (Arc) and Subduction of Indian plates.
Earthquake hazards in North East India.

UNIT -III

Stratigraphic Significance of North Eastern India , Important Stratigraphic horizons in the North East India, Significant Lithology, Economic importance and Life.

UNIT -IV

Geology of Mizoram in the context of rock types, age, fossil content and economic importance. Complete Stratigraphic succession of Mizoram.

UNIT -V

Mineral potential in Mizoram. Present scenario and future prospects. Potential of Oil, Natural Gas and Coal in Mizoram

PRACTICALS (30 Marks)

Preparation of Seismic hazard of map of North East India.
Petrographic study of important rocks from North East India.

BOOKS RECOMMENDED

Dunbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons.
Krishnan, M.S. (1968): Geology of India and Burma, Higginbotham, Madras.
Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
Nandy,D.R.(2000):Geodynamics of North Eastern India and Adjoining Region
Wadia, D.N. (1966): Geology of India, English language Publication

SEMESTER VI

PAPER IX: CORE

PALEONTOLOGY & STRATIGRAPHY –II (70 Marks)

UNIT -I

Binomial nomenclature and procedures in taxonomy; Species concept; Types of fossils; Taphonomy; Collection and preparation of macro- and micro- fossils; Identification of fossils: describing a fossil specimen. Mass Extinction. Paleocology and paleobiogeographic reconstructions

UNIT -II

Evolution of Horse, Man & Elephant. Evolution and extinction of Dinosaurs. Study of Gondwana flora & Siwalik vertebrate fauna. Origin and general characteristic of vertebrates.

UNIT -III

Types of microfossils: Calcareous, Siliceous, Phosphatic, Chitinous, Organic walled and agglutinated. Application of Microfossils in Petroleum Exploration.

UNIT -IV

A detailed study of succession, lithology, age, economic importance and fossil content of the following Indian Stratigraphic horizons:

Archaean of Singhbhum Craton, Proterozoic of Son Valley, Delhi Supergroup, Shimla Formation, Chattisgarh Supergroup, Palaeozoic of Kashmir and Spiti valley

UNIT -V

A detailed study of succession, lithology, age, economic importance and fossil content of the following Indian Stratigraphic horizons:

Paleogene of Assam, Karewas of Kashmir. Neogene succession of Mizoram, Cretaceous of Trichonopoly, Bagh Beds, Lameta Formation. Triassic of Spiti, Jurassic of Kachchh.

PRACTICALS (30 Marks)

Paleontology

Study of morphological characters, systematic positions and age of important genera belonging to the following groups -

Brachiopoda, Bivalvia, Cephalopoda, Gastropoda and Plant fossils.

Distribution of following geological formations on sedimentary basin map of India -

Marine Lower Permian, Gondwana Supergroup, Marine Mesozoics, Deccan Traps and equivalents, Marine Cenozoic and Siwalik Group.

Stratigraphy

Preparation of land / sea distribution on sedimentary basin map of India during Late Precambrian/Early Cambrian, Early Permian, Jurassic, Cretaceous and Eocene; Study of rocks from important Indian stratigraphic horizons. Study of rocks from important stratigraphic horizon of NE India. Biostratigraphic correlation

BOOKS RECOMMENDED

Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ..

Clarkson, E.N.K. (1986): Invertebrate Palaeontology and Evolution, Allen and Unwin Publ.

Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and Animal Distribution, Vishal Publ.

Lehmann, U. (1983): Fossils Invertebrate, Cambridge Univ. Press.

Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997): Invertebrate Fossils, CBS Publ.

Nield, E.W. and Tucker, V.C.T. (1985): Palaeontology: An Introduction, Pergmon Press.

Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.

Rastogi (1988): Organic Evolution, Kedarnath and Ramnath Publ.

Raup, D.M. and Stanley, S.M. (1985): Principles of Palaeontology, CBS Publ..

Shrock, R.R. and Twenhoffel, W.H. (1952): Principles of Invertebrate Paleontology, CBS Publ.

Stebbins (1979): Process of Organic Evolution (3rd Ed.) Prentice Hall.

Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.

Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Dunbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons.

Krishnan, M.S. (1968): Geology of India and Burma, Higginbotham, Madras.

Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.

Wadia, D.N. (1966): Geology of India, English language Publ.

Weller, J.M. (1960): Stratigraphic Principles and Practices, Universal Book.

SEMESTER VI

PAPER X: CORE

ECONOMIC GEOLOGY & MINERAL RESOURCES OF INDIA

(70 Marks)

Unit-I

Processes of formation of ore deposits. Mode of occurrence of ore deposits. Ore forming minerals-metallic and non-metallic. Common forms and structures of ore deposits, Classification of mineral deposits with special reference to Bateman's classification & Lindgreen's classification.

Unit-II

Origin, Mineralogy, geological occurrences, and Indian distribution and uses of: Iron, Manganese, Chromium, copper, Lead, zinc, Gold and Aluminum.

Conventional and Non Conventional Resources. Elementary idea regarding origin & uses of Atomic Minerals (Uranium and Thorium); Non-conventional Energy Resources: Wind, Water, Solar, Geothermal and Biomass Energy.

Unit-III

Non-metallic mineral deposits of India: mica, phosphates, barite, diamond and graphite, with special reference to their origin, distribution, and uses.

Study of important Industrial Minerals: Non-metals related to refractory, fertilizers, cement, chemical and gemstone industry like- Asbestos, Barytes, Gypsum, Mica, Graphite, Talc, Magnesite, Kyanite, Sillimanite, Monazite, Pyrite and Diamond.

Unit-IV

Metallic mineral deposits with reference to their genesis, geologic set up, mineralogy, modes of occurrence, age of: Iron of Chattisgarh-Orissa, Copper of Singhbhum and Malanjkhand, Lead-Zinc of Zawar, Uranium of Jaduguda & Meghalaya, Gold of Hutti, Koderma-Hazaribagh Mica Belt.

Important Gondwana and Tertiary Coal fields of India: Jharia, Important off shore and on shore Oil fields of India: Digboi and Bombay High.

Unit-V

Factors controlling ore mineralization. Concept of Metallogenic provinces and Epochs. Metallogenic Provinces and Epochs in India. Paragenesis, paragenetic sequence and zoning in metallic ore deposits.

PRACTICALS (30 Marks)

Study of ore and economic minerals in hand specimen as detailed in the theory syllabus.

Preparation of maps showing distribution of important metallic and non-metallic deposits and important coal and oil fields of India.

BOOKS RECOMMENDED

Gokhale, K.V.G.K. and Rao, T.C. (1983): Ore Deposits of India, East West Press Pvt. Ltd.
Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley and Sons.
Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.
Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
Pramod, O.Alexander (2009): A Handbook of Minerals, Crystals, Rocks and Ores, New India Publishing Agency New Delhi.
Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad
An Introduction to Ore Geology-AM Evans-ELBS.
Ore Deposits of India-Their distribution and processing-Gokhale and Roa.
Economic Mineral Deposits-Jensen and Bateman-John Wiley and Sons.
India's Mineral Resources-Krishnaswamy and Sinha-Oxford and IBH Publishing co. Pvt; Ltd.
Mineral deposits of India-DK Banerjee
Geology of Ore deposits-Smimov;
Indian Mineral Deposits-K.K Chatterjee.
Sedimentary Rocks-F. Pettijohn CBS Publishers and Distributors
Ore Geology – A.K. Mukherjee

SEMESTER VI

PAPER XI: CORE

DYNAMICS OF THE EARTH & STRUCTURAL GEOLOGY

(70 Marks)

Unit -I

Earth; shape, mass, density, rotational and revolution parameters; Distribution & Elemental abundance in crust, Mantle and Core. Magnetic field; Radioactivity and Geo-chronology of the Earth; Internal structure of the Earth; Geochemical Evolution of the Earth; Geophysical conditions of the Earth: Gravity, magnetism and heat flow.

Unit – II

Earth's movement and Paleographic distribution and evolution of continents and basin through Geological time (Special emphasis on India's changing position). Plate tectonic theories, types of plate boundaries, causes of Plate motion & Paleogeographic and paleontological evidences of Plate tectonics.

Unit –III

Agents of weathering and erosion. Basic idea about the geological work of natural agencies - rivers, glaciers, ocean and wind. Concept of Isostasy and Orogeny.

Unit-IV

Earthquakes, causes, elastic rebound theory, focus and epicenter, intensity and magnitude. Seismic waves, seismograms, travel-time curves for seismic waves, seismic discontinuities, location and size of earthquake, and determining magnitude. Earthquake belts. Effects of earthquakes, seismic zones of India.

Unit-V

Descriptive terminology, origin and relation to major structures; Cleavage and Schistosity, Secondary Lineation, Stereographic projection and its use in structural analysis. Beta & Pi Diagrams, Elementary concept of stress & strain; three-dimensional strain and stress analyses and its application in deformed rocks; Brittle failure and ductile deformation.

PRACTICALS (30 Marks)

Interpretation of seismogram

Problems on half-life calculation

Problems on drainage system

Study of models on

1. Plate margins
2. Mid -oceanic ridges.
3. Trenches.

Structural problems on Stereographic projection.

Regional Geological Field Work

BOOKS RECOMMENDED

Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall, London.

Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.

Mallory, B.F and Cargo, D.N. (1979): Physical Geology, McGraw Hill.

Monrow, James S. (1986): Physical Geology: Exploring the Earth, Booke Cole, Australia.

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III, Academic Press.

Ritter, Dale F. (1986): Processes of Geomorphology. Wm C. Brown Publ.

Singh, S (2001): Geomorphology, Prayag Pustak Bhandar, Allahabad

Sitter, L.U. De (1959): Structural Geology, Mc Graw Hill Publ.

Strahler, A. N. and Strahler, A.H. (1973): Environmental Geoscience, Hamilton Publ. Co.

Turner, F.J. and Weiss, L.E. (1963): Structural Analysis of Metamorphic Tectonites McGraw Hill Book Co.

SEMESTER-VI

PAPER XII: CORE

Option-A: FUEL GEOLOGY & MINERAL EXPLORATION (70 Marks)

Unit-I

Petroleum: Definition, Composition, Origin, Migration and Entrapment. Study of source-reservoir and trap rocks and their characteristics. Study of important oil fields in India: Rajahmindi, Naharkatia and Borhola oil field. Reserves of oil in India.

Unit-II

Coal: Definition, Chemical, Petrographic Constituents, origin and Classification of coal. Coal reserves of India. Distribution of Coal with special reference to important Indian Coal fields: Gondwana (Ranigaj) and Tertiary (Neyveli and Kashmir).

UNIT -III

Principles of exploration. Stages of geological exploration. Methods of geological mapping and sampling. Classification of ore reserves and determination of Average grades. Brief idea about drilling and Coring.

UNIT -IV

Principles of geochemical exploration, Detailed methods of Geochemical Exploration and sampling, Assay maps, Anomaly maps, Geochemical profile generation. Geobotanical and Geozoological indicators applicable in mineral exploration.

UNIT -V

Geophysical Exploration techniques: Electrical (Self Potential, Equi-potential, Resistivity and Conductivity methods), Seismic Reflection & Refraction Methods. Gravity, Magnetic and Radioactivity Methods. Geophysical Well Logging: Spontaneous Potential, Gamma Ray, Resistivity Logs and their response with Lithology encountered through a borehole and different applications.

PRACTICALS (30 Marks)

Study of ore and economic minerals in hand specimen as detailed in the theory syllabus; Preparation of maps showing distribution of important metallic and non-metallic deposits and

important coal and oil fields of India. Representation of Important mineral deposits on the map of India. Resistivity survey.

Preparation of Assay and Isograde maps.

BOOKS RECOMMENDED

- Gokhale, K.V.G.K. and Rao, T.C. (1983): Ore Deposits of India, East West Press Pvt. Ltd.
- Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley and Sons.
- Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.
- Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
- Pramod, O.Alexander (2009): A Handbook of Minerals, Crystals, Rocks and Ores, New India Publishing Agency New Delhi.
- Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals, Dhanbad
An Introduction to Ore Geology-AM Evans-ELBS.
- Ore Deposits of India-Their distribution and processing-Gokhale and Roa.
- Economic Mineral Deposits-Jensen and Bateman-John Wiley and Sons.
- India's Mineral Resources-Kriskhnaswamy and Sinha-Oxford and IBH Publishing co. Pvt;
Ltd.
- Mineral deposits of India-DK Banerjee
- Geology of Ore deposits-Smimov;
- Indian Mineral Deposits-K.K Chatterjee.
- Sedimentary Rocks-F. Pettijohn CBS Publishers and Distributors
- Ore Geology – A.K. Mukherjee

SEMESTER-VI

PAPER XII: CORE

Option-B: ENVIRONMENTAL GEOLOGY (70 Marks)

UNIT -I

Definition and dimensions of environment; General idea about components and composition of different environmental domains such as atmosphere, hydrosphere and biosphere; Introduction to weather and climate; Past-climates in the earth history;

UNIT -II

Geo –Hazards: Mass movements, Earthquakes, Tsunami, floods, Volcanic Eruptions, Cyclones, Their origin, types and causes. Disaster prevention and Mitigation measures.

UNIT -III

Earth's Heat Balance, Global Climatic changes, Composition and structure of Atmosphere, Cloud forms and classification; Land-Sea and Air Interaction.
Concept of Monsoon, El Nino and La Nina, Impact of El Nino and La Nina on Global Climate

UNIT -IV

Types of environmental pollution; Environmental consideration in Industrialization. Industrial pollution and Industrial Waste Disposal.

UNIT -II

Geoenvironmental hazards in Mizoram. Impact of Urbanization on the Geo-environment
Problems of land degradation and Landslides.

PRACTICALS (30 Marks)

Exercises on Seismic Zonation Map.

Interpretation of Environmental impact from field data provided.

Field visit to landslide affected areas.

BOOKS RECOMMENDED

Environmental Geology _Montgomery, Carla,W- Mc Graw Hill .

Brown, C. and Dey, A.K. (1955): Indian Mineral Wealth, Oxford Univ.

Duncan Foley(2010) Investigations in Environmental Geology, Pearson Education,United Kingdom

Garry McKenzie, Russell Utgard(2007)Natural Hazards, Pearson Education,United Kingdom

Edward Keller (2009) Introduction toEnvironmental Geology,9th Edition, Pearson Education,United Kingdom

Hobart King (2007) Hazard City,Assignments in Applied Geology, 3rd Edition, Pearson Education,United Kingdom

Steve Kluge(2009) Encounter Earth Interactive Geoscience Explorations, Pearson Education,United Kingdom

Travis Hudson (2010)Living with Earth. Pearson Education,United Kingdom
