B.SC. (HONS.) GEOLOGY SYLLABUS
MANIPUR UNIVERSITY

B. Sc. (Hons.) GEOLOGY SYLLABUS, SEMESTER SYSTEM

The B. Sc. (Hons.) Geology shall be imparted to students for three academic sessions consisting of six semesters. Candidates will be examined and evaluated on grade point basis at the end of each semester in the different courses of theory and practical as per marks/credits given against each course. The B. Sc. (Hons.) Geology will consist of (a) Core Courses and (b) Geological Field Work.

a) The Core courses will be compulsory for all the students. There will be eleven theory and six practical papers in the core course. Papers carrying 100 marks will of 4 credits, 75 marks 3 credits and 25 marks 1 credit covering major branches of Geology. There will be total 1000 marks distributed in 40 credits.

b) Geological field work will be compulsory at the end of I, III, IV, V and VI semesters. The students who fail to attend the geological field work, their results will be withheld. The geological field work will be conducted inside or outside the state depending upon the purpose. The semester breaks can also be utilized for the geological field work.

The scheme of papers shall be as follows:

FIRST SEMESTER

THEORY

Paper Code	Title	Marks
GL-101: (Theory)	General Geology, Structural Geology & Geomorphology	75
	General Geology	25
	Structural Geology	25
	Geomorphology	25

(PRACTICAL):

	Geomorphology, Structural Geology and Field Work	25
	Geomorphology	8
	Structural Geology	10
	Field Work (for 3 days)	4
	Viva voce	3

SECOND SEMESTER

THEORY

Paper Code	Title	Marks
GL-202: (Theory)	Descriptive & Optical Mineralogy, Crystallography and Geochemistry	75
	Descriptive Mineralogy	25
	Optical Mineralogy	25
	Crystallography & Geochemistry	25

(PRACTICAL):

	Descriptive Mineralogy, Optical Mineralogy and Crystallography	25
	Descriptive Mineralogy	8
	Optical Mineralogy	8
	Crystallography	6
	Viva voce	3

THIRD SEMESTER

THEORY

Paper Code	Title	Marks
GL-303: (Theory)	Petrology	75
	Igneous Petrology	25
	Metamorphic Petrology	25
	Sedimentary Petrology	25

(PRACTICAL):

	Petrology and Field Work	25
	Igneous Petrology	6
	Metamorphic Petrology	6
	Sedimentary Petrology	6
	Field Work (for 3 days)	4
	Viva voce	3

FOURTH SEMESTER

THEORY

Paper Code	Title	Marks
GL-404: (Theory)	Palaeontology and Stratigraphy	75
	Palaeontology	35
	Stratigraphy	40

(PRACTICAL):

	Palaeontology, Stratigraphy and Field Work	25

Palaeontology	12
Stratigraphy	6
Field Work (for 3 days)	4
Viva voce	3

FIFTH SEMESTER

THEORY

Paper Code	Title	Marks
GL-(H) 505: (Theory)	Structural Geology, Tectonics and Petrology	100
	Structural Geology and Tectonics	25
	Igneous Petrology	25
	Sedimentary Petrology	25
	Metamorphic Petrology	25
GL-(H) 506: (Theory)	Economic and Fuel Geology, Mineral Economics and Mining Geology	100
	Economic Geology	30
	Mineral economics	20
	Fuel Geology	30
	Mining Geology	20

(PRACTICAL):

GL-(H) 507(P):	Structural and Economic Geology, Petrology and Field Work	100
	Structural Geology	25
	Petrology	30
	Economic Geology	15
	Field Survey	10
	Field Work (to visit mines etc. for 1 week)	15
	Viva voce	5

SIXTH SEMESTER

THEORY

Paper Code	Title	Marks
GL-(H) 608: (Theory)	Geophysics, Engineering Geology and Hydrogeology	100
	Geophysics	30
	Engineering Geology	40
	Hydrogeology	30
GL-(H) 609: (Theory)	Environmental &Quaternary Geology, Photogeology, Remote Sensing and Computer Application	100
	Environmental Geology	25
	Quaternary Geology	25
	Photogeology, Remote Sensing	25
	Computer Application	25

(PRACTICAL):

GL-(H) 610(P):	Hydrogeology, Environmental &Quaternary Geology, Photogeology, Remote Sensing, GIS, Seminar and Field Work and	100
	Geophysics	20
	Hydrogeology	25
	Photogeology, Remote Sensing, GIS	25
	Seminar	15
	Field Work (for 3 days)	10
	Viva voce	5

SEMESTER – I

GL-101: GENERAL GEOLOGY, STRUCTURAL GEOLOGY AND GEOMORPHOLOGY: 75

Unit-1 General Geology **25**

Introduction to Geology, scope, sub-disciplines and relationship with other branches of science. Earth in the solar system, its origin, size, shape, mass and density. Internal constitutions of the Earth. Convections in the earth's core and production of magnetic field; Composition of earth in comparison to other bodies in the solar system; Origin of hydrosphere and atmosphere, biosphere; Origin of oceans, continents and mountains; Age of the earth; Radioactivity and its application in determining the age of the earth. Earthquakes - causes, geological effects and their measurement, distribution of earthquake belts; Volcanoes - types, causes and geological effects, distribution of volcanic belts; Relationship of earthquakes with volcanic belts; Weathering and erosion; Soil - formation, profile and types; Geological time scale; Major events in the earth's history.

Unit-2 Structural Geology: **25**

Introduction, scope and objectives of structural geology. Primary (non-diastrophic) structures of sedimentary and igneous rocks and their uses. Concept of dip and strike, contour and stratum contour maps. Concept of lamination, stratification and bedding. Different types of bedding. Overlap and offlap. Topography and its representation; Outcrop, effects of topography on outcrop. Folds-definition and description. Concept of pitch and plunge. Classification of folds with special reference to morphological/geometric/genetic classification. Faults - definition and description; types and classification of faults. Joints- definition, description, classification, genesis and uses. Unconformity -definition, type, recognition and utilities. Offlap and Overlap; Outlier and inlier.

Unit-3 Geomorphology: **25**

Basic concepts of geomorphology. Exogenic and endogenic geomorphic processes; Evolution of landscape; A detailed account of the geological work of natural agencies - groundwater and springs, rivers, glaciers, lakes, ocean and wind, and landforms associated with them. Geomorphic cycles. Soil and soil forming processes. Geomorphic sub-divisions of India and their salient features. Origin and classification of mountains; Concept and theories of isostasy; continental drift theory, sea floor spreading and brief idea about plate tectonics and distribution of plates; various structures associated with different plate boundaries. Origin and significance of mid oceanic ridges, trenches and island arc; expanding and contracting earth. Mitigation of environmental hazards - earthquakes, landslides, floods.

PRACTICALS: 25

Geomorphology: 8

Study of important geomorphological models. Identification and interpretation of geomorphic features from the topographical map. Identification of different drainage patterns. Reading topographical maps of the Survey of India. Concept of contour, scale and other topographic features. Preparation of slope maps. Preparation of longitudinal and cross-valley and superimposed profiles. Recognition of regional erosion surfaces.

Structural Geology: 10

Study of clinometer and Brunton compass. Concept of stratum/structural contour maps. Completion of geological outcrop maps. Study and interpretation of geological maps-geological cross-section containing folds, faults, unconformities, dykes and sills. Determination of heave and throw of faults.

Field Work: 4

Pertaining to study on primary sedimentary structures, secondary structures like folds, faults, unconformity, joints, etc. Measurement of strike direction, dip direction and amount of dip of planar rock surfaces.

Viva voce: 3

Books Recommended:

Billings, M.P. (1972): Structural Geology, Prentice Hall.

Bhatta, B., (2008). Remote Sensing and GIS. Oxford, New Delhi.

Bloom, A.L. (1998). Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition), Pearson Education, Inc.

Davis, GR. (1984). Structural Geology of Rocks and Region. ohn Wiley

Dennis, J.G. (1972): Structural Geology, Ronald Press Company, New York.

Ghosh, SK. (1993). Structural geology: fundamentals and modern developments, Pergamon Press, London

Gupta, R.P. (2003). Remote Sensing Geology. 2nd Ed., Springer-Verlag, Heidelberg, Germany.

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.

Kale, VS. and Gupta, A. (2001). Introduction to Geomorphology. Orient Longman Ltd.

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.

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

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

Ruhe, R.V. (1975): Geomorphology, Houghton Miffin Co., Boston.

Singh, R. P. (1995): Structural Geology, A Practical Approach, Ganga Kaveri Publ., Varanasi.

Sparks (1960): Geomorphology, Longmans, London.

SEMESTER – II

GL-202: DESCRIPTIVE MINERALOGY, OPTICAL MINERALOGY, CRYSTALLOGRAPHY AND GEOCHEMISTRY: 75

Unit-1 Descriptive Mineralogy: 25

Minerals, definition and classification. Common physical properties of minerals. Classification of minerals and silicates. Mode of occurrence and genesis. Study of physical, chemical and optical properties of the following minerals (group/species)-silica, feldspars, feldspathoids, micas, amphiboles, pyroxenes, olivines, garnet, beryl, topaz, tourmaline, zircon, apatite, fluorite, calcite, dolomite, gypsum, zeolite, corundum, spinel, etc.

Unit-2 Optical Mineralogy: 25

Nature of light wave; wave surface in isotropic and anistropic minerals, electro-magnetic spectrum, simple harmonic motion. Reflection, refraction, total internal reflection. Becke's effect. Double refraction, Nicol prism, Petrographic microscope and its handling. Polarization of light - ordinary and polarized lights. Absorption, dispersion, pleochroism, quartz-wedge, Mica pate and gypsum plate compensation. Optical properties of some common rock forming minerals (quartz, orthoclase, microcline, plagioclase, garnet, biotite, muscovite, augite, hypersthene, hornblende, olivine and calcite). Uniaxial and biaxial interference figures.

Unit-3 Crystallography & Geochemistry: 25

Crystallography 15

Definition of a crystal. Crystalline and non-crystalline forms and their formation. Crystal growth theory. Bravais (Space) lattices and internal structure of the crystals. External forms and symmetry. Crystallographic axes, axial ratio, crystal indices/ parameters, Miller Indices. Crystal forms and crystal habit. Zoned crystals and twinned crystals. Laws of twinning. Composite crystals. The seven crystal systems and study of 32 classes.

Geochemistry: 10

Definition and scope of the subject, composition of earth and cosmos, periodic table, crystal bonding, co-ordination principle, radius ratio, polymorphism, pseudomorphism, solid solution and isomorphism, geo-chemical classification of elements, chemical and mineralogical phase rule.

PRACTICALS: 25

Descriptive Mineralogy: 8

Study of physical properties and identification of minerals in hand specimen. Determination of specific gravity of common minerals.

Optical Mineralogy: 8

Use of polarizing microscope. Study of optical properties of important rock forming minerals.

Crystallography: 6

Study of elements of symmetry of representative crystals from each system. Determination of interfacial angles.

Viva voce: 3

Books Recommended:

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).

Deer, W. A. , Howie, R. A. and Zussman, J., An introduction to the rock forming minerals. ELBS publication,1962-1963.

Kerr, P. F. (1977): Optical Mineralogy. McGraw Hill.

Moorhouse, W.W. (9151): Optical Mineralogy, Harper and Row Publ.

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 Murby and Co.

Verma, P.K., Optical mineralogy, CRC press 2009

SEMESTER – III

GL-303: PETROLOGY : 75

Unit-1 Igneous Petrology: 25

Introduction and scope of the subject. Forms, structures and textures of igneous rocks. Composition and constitution of Magma. Formation and classification of igneous rocks. Phase rule and its application to H_2O system. Crystallization of Uni-component and Bi-component magma system. Bowen's Reaction Principles. Magmatic differentiation and assimilation: Brief petrographic description and petrogenesis of common igneous rocks - granite, granodiorite, diorite, syenite, rhyolite, trachyte, gabbro, dolerite, basalt, pyroxenite and peridotite.

Unit-2 Sedimentary Petrology : 25

Introduction and scope of the subject. Sedimentary processes: origin, transportation and deposition of sediments and brief study on environment of deposition. Lithification and diagenesis of sediments. Composition, texture and primary structures of sedimentary rocks. Classification of sedimentary rocks. Study on important clastic and non-clastic sedimentary rocks. Concept of shape, size, roundness and sphericity of sedimentary particles.

Unit-3 Metamorphic Petrology: 25

Introduction and scope of the subject. Definition of Metamorphism, Agents and types of metamorphism. Concept of depth zone and grade of metamorphism. Classification of metamorphic rocks. Texture, structure and nomenclature of metamorphic rocks. Common metamorphic rocks and their protoliths such as slate, phyllite, schist, gneiss, hornfels, marble, quartzite with some important Indian type rock. Stress and anti-stress minerals. Thermal and regional metamorphism of argillaceous, calcareous sediments and basic and ultrabasic rocks.

PRACTICALS: 25

Igneous Petrology: 6

Study of petrological microscope. Megascopic and microscopic study of the following rock types: Granite, syenite, diorite, gabbro, peridotite, rhyolite, trachyte, dolerite, basalt, dunite, serpentinite, etc.

Metamorphic Petrology: 6

Megascopic and microscopic study of the following rock types:
Slate, phyllite, schist, gneiss, quartzite, marble.

Sedimentary Petrology: 6

Study of sedimentary structures from hand specimens, photographs and drawings. Megascopic and microscopic study of the following rock types: Sandstone, shale, siltstone, limestone, conglomerate and breccia.

Field Work: 4

Pertaining to study on identification of different kinds of rocks in the field, collection of rock samples.

Viva voce: 3

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.

Bose M.K. 1997. Igneous Petrology. World Press

Bucher K. and Martin F. 2002. Petrogenesis of Metamorphic rocks. Springer-Verlag Publication.

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

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

Lindholm, R.C., 1987, A practical approach to sedimenmtology, Allen and Unwin, London

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

Pettijohn, F. J. 1975, Sedimentary Rocks, 3rd edn. CBS Publ. New Delhi

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

SEMESTER – IV

GL-404: PALEONTOLOGY AND STRATIGRAPHY: 75

Unit-1 Principals of Palaeontology & Stratigraphy: 25

Definition, sub-divisions and scope of Palaeontology, its relationship with other sub-disciplines of geology; Fossils, definition, kinds (body and trace fossils); various modes of preservation of fossils - their collection, preparation and preservation. Index fossils and its significance. Principles of stratigraphy; modern stratigraphic classification. Geological time scale; Elements of stratigraphic classification; Rock units, time units and time rock units. Brief outline of the standard geologic column of the Indian Stratigraphic sequences. Indian stratigraphic code and nomenclature. Methods of collecting stratigraphic data; Identification of stratigraphic contact.

Unit-2 Palaeontology: 25

A detailed study of the morphology and geological distribution of the following phylum/classes/orders-Brachiopoda, Mollusca (class-Pelecypoda and Gastropoda); Arthropoda (class –Trilobita). General morphology, classification and significance of foraminifera. Concept of micro-

palaeontololgy. A brief account of vertebrate life through ages. Vertebrate records of India and study of the evolution of horse, man and elephants. Concept of palaeobotany. Classification of plant kingdom. Systematic position, description and stratigraphic significance of the following plant fossils - *Glossopteris*, *Gangamopteris*, *Ptyllophyllum Vertebraria*, *Schizoneura*, *Stigmaria*, and *Nilssonia*. Morphology and palaeo-environmental significance of important trace fossils of *Skolithos*, *Cruziana* and *Nereites* ichnospecies. Application of palaeontology with special reference to sequence stratigraphy, correlation, palaeo-ecology and palaeo-biogeographic reconstructions.

Unit-2 Indian Stratigraphy 25

Connotation of the terms Archean, Dharwar, Cuddapah, Vindhyan, Gondwana. Study of the following supergroups of Indian Precambrian rocks with special reference to lithology, tectonics and economic significance - Dharwar of Karnataka, Cuddapah of Andhra Pradesh and Vindhyan of Son valley, Singhbhum, Assam plateau. Gondwana Supergroup and Tertiary of Manipur. Elements of facies concept in stratigraphy.

PRACTICALS: 25

Paleontology: 12

Study of morphological characters of about 30 genera pertaining to Trilobita, Graptoloidea, Echinoidea, Anthozoa, Bivalves, Gastropods, Cephalopods, Brachiopods, Mega foraminifers. Morphological study and identification of the following plant fossils – *Glossopteris*, *Gangamopteris*, *Vertebraria*, *Nilssonia*, etc.; and trace fossils – *Skolithos verticalis*, *Thalasinoides paradoxicus*, *Ophiomorpha nodusa*, etc.

Stratigraphy: 5

Preparation of lithostratigraphic maps of India showing distribution of the following- Dharwar Supergroup, Cuddapah Supergroup, Vindhyan Supergroup, Gondwana, Tertiaries. Sequence stratigraphic interpretation of measured lithocolumn of selected sections in Manipur.

Field Work: 5

Pertaining to study on collection and identification of fossils; preparing lithocolumn for sequence stratigraphic interpretations.

Viva voce: 3

Books Recommended:

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

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

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

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

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

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

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

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.

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 – V

GL-(H) 505: STRUCTURAL GEOLOGY, TECTONICS AND PETROLOGY: 100

Unit-1 Structural Geology & Tectonics: 25

Minor structures associated with folds and recognition of folds in the field. Simple mechanics of folding. Rock deformation. Recognition of faults in the field. Simple mechanics of faulting. Minor structures associated with faults. Differentiation of faults and unconformities in the field. Association of joints with major structures. Genesis and utilization of cleavage/foliation. Basic concepts of stress and strain and their uses in structural geology. Effects of faulting on the outcrops; Geometric and genetic classification of joints; Foliation, descriptive terminology, origin and relation to major structures; Stereographic projection and its use in structural analysis.

Concept of tectonics/geo-tectonics. Brief studies on isostasy, geosynclines, continental drift theory, expanding and contracting earth, island arc, sea floor spreading, paleo-climate.
Concept of plate tectonics and various structures associated with different plate boundaries. Brief idea about tectonic framework of the Himalayas and the Indo-Myanmar Ranges.

Unit-2 Igneous Petrology: 25

Physical properties, genesis, evolution and types of magma; igneous cumulates, liquid immiscibility, pneumatolitic action, magmatic assimilation and mixing of magmas Concepts of rock series and rock association; Phase equilibrium in one (SiO_2), two (Di-An, Fo-Silica, Ab-An) and three (Di-Ab-An and Di-Fo-An) component silicate systems. Elements of thermodynamics in magmatic crystallization. IUGS mineralogical (QAPF) and chemical (total alkali-silica diagram) classification schemes; Common igneous textures; Detailed petrographic description of granite, granodiorite, diorite, syenite, phonolilte, gabbro, norite, dolerite, basalt, andesiste, dunite, pyroxenite, peridotite, komatite, trachyte, rhyolite and dacite.

Unit-3 Metamorphic Petrology: 25

Phase rule and Goldschmidt's mineralogical phase rule; Chemical equilibrium in metamorphism. Principles of metamorphic reactions, metamorphic facies and metamorphic facies series; Graphical representation of mineral assemblages in ACF, AKF, AFM diagrams; Prograde, retrograde and polymetamorphism. Metamorphic differentiation and concept of metasomatism. Metamorphism and melting, origin of migmatities. Progressive metamorphism of (a) Pelitic rocks in K_2O – FeO-MgO-Al_2O_3-SiO_2 system, (b) Basic rocks in CaO – FeO – MgO – Al_2O_3 – SiO_2 system, (c) Calcareous rocks in CaO – MgO –SiO_2 – CO_2 – H_2O system; (d) Ultramafic rocks in MgO – Al_2O_3 – SiO_2 – H_2O system.

- Unit-4 Sedimentary Petrology : 25

Processes of formation of sedimentary rocks. Classification of rudaceous, arenaceous, argillaceous and calcareous rocks. Sedimentary Structures and Paleocurrent analysis. Mineralogical characteristics, textures, and diagenesis of sedimentary rocks. Heavy minerals and provenance interpretations. Techniques of grain size analysis and graphical representations. Petrographic details of important siliciclastic and carbonate rocks such as - conglomerate, breccia, quartz-arenite, arkose, lithic arenite, quartzwake, felspathicwacke, lithicwacke, mudrocks / shale, limestones: crystalline, micritic and sparitic.

GL-(H) 506: ECONOMIC GEOLOGY, MINERAL ECONOMICS, FUELS GEOLOGY, MINING AND EXPLORATION GEOLOGY: 100

Unit-1 Economic Geology: 25

Scope of the subject. Definition of ore, ore mineral and gangue. Tenor of ore. Classification of ore deposits. Mineralization and mineral deposits. Concept of syngenetic and epigenetic deposits. Forms and structures of mineral deposits. Brief idea about ore forming processes - magmatic, metasomatic, metamorphic, hydrothermal, placer, residual deposits and oxidation and supergene suphide enrichment. Concepts of metallogenic epoch and province. Paragenesis, paragenetic sequence and zoning in metallic ore deposits.

Study of Indian deposits of the following ores and minerals with reference in their geology, mode of occurrence, distribution, uses of - magnetite, hematite, chromite, psilomalane, pyrolusite, chalcopyrite, galena, sphalerite, native gold, magnesite, bauxite, pyrite, diamond, muscovite, beryl, fluorite, gypsum, barite, halite, phosphorite, talc, kyanite, graphite, asbestos, monazite and corundum; Precious and Semi-precious minerals.

Unit-2 Mineral Economics: 25

Study of important industrial minerals of India with particular reference to the industries - cement, glass and ceramics, refractory, fertilizer and building stones, chemicals and gemstones. Significance of minerals in national economy. Demands, supply and substitute of minerals. Resources and reserves, their classification.

Unit-3 Fuel Geology: 35

Fundamentals of coal petrology, origin of Coal. Stratigraphy of Coal Measures. Overview of Indian coal deposits. Origin of petroleum and natural gas, surface indicators of oil shows, migration of oil, petroleum reservoirs and various types of oil traps. Onshore and off-shore distribution of petroliferous basins in India. A brief study of atomic fuels.

Unit-4 Mining and Exploration Geology: 25

Relationship between geology and mining. Different terms used in mining. Concept of Mining methods - surface mining and alluvial mining, mineral sand, open pit and open cast mining and underground mining. Fundamentals of geological, geochemical and geophysical techniques employed in exploration of mineral deposits.

GL-(H) 507(P) : PRACTICALS: 100

Structural Geology: 20

Exercises on structural geology problems: Graphic solutions of dip and strike problems. Three and four points problems of thickness determination. Stereographic projection of structural data. Plotting

of fold limbs, faults, joints/fractures. Evaluation of pitch and plunge from stereographic map. Concept of and β diagrams.

Igneous Petrology: 10

Calculation of C.I.P.W. norm of oversaturated rocks. Calculation of Niggli value of rocks.

Metamorphic Petrology: 10

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

Sedimentary Petrology: 10

Grain size analysis and preparation of histogram, frequency curves on the basis of grain size data. Presentation of palaeocurrent data. Examination of some common heavy minerals in grain mounts.

Economic Geology: 20

Study of ore and economic minerals in hand specimens 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.

Surveying: 10

Using Plane Table, Prismatic Compass and Dumpy Level.

Field Work – visit to mine 15

Viva voce: 5

Books Recommended:

Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.

Billings, M.P. (1972): Structural Geology, Prentice Hall.

Bjorlykke, Sedimentary and Petroleum Geology.

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

Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.

Ghosh, S.K. (1993): Structural Geology, Pergamon Press, New York.

Gokhale, K.V.G.K. and Rao, T.C. (1983): Ore Deposits of India, East West Press Pvt. Ltd.

Jensen, 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.

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.

McKinstry, H.E. 1962. Mining Geology (2nd Ed.) Asia Publishing House.

Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.

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

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

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

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

SEMESTER – VI

GL-(H) 608: GEOPHYSICS, ENGINEERING GEOLOGY AND HYDROGEOLOGY: 100

Unit-1 Geophysics: 25

Interrelationship between geology and geophysics. Role of geological and geophysical data in explaining geodynamical features of the earth. General and Exploration geophysics-Different types of geophysical methods like: Gravity, Magnetic, Electrical and Seismic, their principles and applications. Physical properties of rocks and minerals giving anomalies leading to the idea of geophysical properties. Application of geophysical methods in oil, gas, minerals and groundwater explorations.

Unit-2 Engineering Geology: 25

Geology vs. Engineering. Role of Engineering geologists in planning, design and construction of major man-made structural features. Elementary concepts of rock mechanics and rock engineering. Soil mechanics. Site investigation, characterization and problems related to civil engineering projects: foundation treatment, geological and geotechnical investigations for dams, reservoirs and spillways, tunnels, underground caverns, bridges, highways, shorelines.

Unit-3 Engineering Geology: 25

Environmental considerations related to civil engineering projects. Construction materials. Geological hazards (landslides and earthquakes) their significance, causes and preventive/remedial measures. Slope stability studies and Earth-quake Zonation and aseismic design of structures. Recent trends in geotechnical engineering. Case histories studies with Indian examples.

Unit-4 Hydrogeology: 25

Definition of hydrogeology, geohydrology and hydrology; Hydrological cycle and groundwater in the hydrological cycle; Hydrological parameters-Precipitation, evaporation, transpiration and infiltration; Origin and age of groundwater; Vertical distribution of groundwater; Types of aquifers; Water bearing properties of rocks - Porosity and Permeability; springs and their formations; Darcy's law and its validity; Dissolved constituent of groundwater; Salinization of groundwater; Groundwater provinces of India.

GL-(H) 609: ENVIRONMENTAL GEOLOGY, QUARTERNARY GEOLOGY, PHOTOGEOLOGY, REMOTE SENSING AND COMPUTER APPLICATION: 100

Unit-1 Environmental Geology: 25

Fundamental concept of Environmental Geology. Environmental hazards caused by earth processes viz., River, Landslide, Volcanoes, Cyclone. Pollution - sediments, ground water, solid waste disposal, radioactive waste, water management. Mineral resources and environment. Environmental impact of mineral development, recycling of resources, land-use planning in relation to engineering projects.

Unit-2 Quarternary Geology: 25

Definition of Quaternary, the Character of Quaternary, duration of the Quaternary and development of Quaternary studies. Quaternary stratigraphy- Oxygen isotope stratigraphy, biostratigraphy and

magnetostratigraphy. Response of geomorphic, neotectonic, active tectonics and their application to natural hazard assessment. Quaternary dating methods: Radiocarbon, Uranium series Luminescence, Amino Acid, Relative dating methods. Application of pollen, spores and phytoliths in Quaternary stratigraphy.

Unit-3 Photogeology & Remote Sensisng: 25

Types and acquisition of aerial photograph. Scale and resolution. Black and white, colour and infrared film. Photomosaics. Principles of stereoscopy, lens and mirror stereoscopes, image parallax, relief displacement, vertical exaggeration, distortion. Elements of airphoto interpretation. Identification of sedimentary, igneous and metamorphic rocks. Aeolian, glacial, fluvial and marine landforms. Physical principles of remote sensing. Early history of space imaging. Earth Resources Satellites: Characteristics and applications of imageries of LANDSAT1 to 7, SPOT missions, Indian Remote Sensing Satellite mission. Basic idea of Radar Images.

Unit-4 Computer Application: 25

Fundamentals of computer operating systems: MS Office (Microsoft Office Word, Microsoft Office Excel Microsoft Office Power Point etc.). Application of computer soft Wares in geological sciences GeOrient, ROCKPACK III and Soft ware Norm Calculations. Use of MapInfo 8 and ArcGIS 9.2 for preparation of geological maps and lithologs.

GL-(H) 610 (P): PRACTICALS: 100

Geophysics: 20
Preparation and interpretation of gravity, magnetic and electrical anomaly profiles and contour maps.

Hydrogeology: 20
Preparation and interpretation of water table maps. Plotting of groundwater provinces of India on a map of India.

Photogeology, Remote Sensing and GIS: 30

Study of aerial photo-pairs using lens and mirror stereoscopes delineating geomorphic features (aeolian, fluvial, glacial and coastal), rock types (igneous, sedimentary and metamorphic and unconsolidated sediments) and structural features (fold, faults, joints, caverns, lineaments). Recognition of various topographic features from satellite imageries. Calculation of scale from aerial photographs. Preparation of geological drainage maps from photographs.

Field Work: 15
Pertaining to observation of Quaternary deposits, river terraces, neotectonic and active tectonic evidences.

Seminar: 10

Viva voce 5

Books Recommended:

Bhimasarikaran V.L.S., (1990). Exploration Geophysics - An Outline by Association of Exploration Geophysicists, Osmania University, Hyderabad.

Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.

Davis, S.N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.

Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, John Wiley.

Surveying and Mining Geology 10

Surveying: 5

Elementary concept of surveying, plane table survey, chain and compass survey, leveling using dumpy level. Plotting of geological and structural features.

Mining Geology: 5

Preparation of mine charts, plans and sections on the basis of data given. Estimation of reserves by simple arithmetic and others methods

Viva voce 5

Books Recommended:

Arogyaswami, R.P.N., 1996: Courses in Mining Geology. 4th Ed. Oxford-IBH.

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

Clark, G.B., 1967: Elements of Mining. 3rd Ed. John Wiley & Sons.

Evans, A.M., 1993: *Ore Geology and Industrial Minerals.* Blackwell.

Gokhale, K.V.G.K. and Rao, T.C., 1983: Ore Deposits of India, East West Press Pvt. Ltd.

Jensen, 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.

McKinstry, H.E., 1962: Mining Geology (2nd Ed.) Asia Publishing House.

Mookherjee, A., 2000: Ore Genesis-A Holistic Approach, Allied Publisher.

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

Smirnov, V.I., 1978: Geology of Ore Deposits, MIR Publications, Moscow

SEMESTER – VI

GL-606: ENGINEERING GEOLOGY, HYDROGEOLOGY AND ENVIRONMENTAL GEOLOGY, PHOTOGEOLOGY AND REMOTE SENSING 75

Unit-I Engineering Geology 25

Geology vs. Engineering. Role of Engineering geologists in planning, design and construction of major man-made structural features. Elementary concepts of rock mechanics and rock engineering. Soil mechanics. Site investigation, characterization and problems related to civil engineering projects: foundation treatment, geological and geotechnical investigations for dams, reservoirs and spillways, tunnels, underground caverns, bridges, highways, shorelines. Environmental considerations related to civil engineering projects. Construction materials. Geological hazards (landslides and earthquakes) their significance, causes and preventive/remedial measures. Case histories and Indian examples.

Unit-II Hydrogeology and Environmental Geology 25

Hydrogeology 15

Concept of photogeology. Basic concepts of scales, resolution, annotation, mosaic. Black and white, colour and infrared film. Photomosaics. Fundamentals of air-photo interpretation techniques for vegetation, drainage, lithology. Identification of sedimentary, igneous and metamorphic rocks, Aeolian, glacial, fluvial and marine landforms. Basic concepts of remote sensing; Thermal and multispectral scanning, microwave sensing. Indian Remote Sensing Satellite mission. Basic idea of Radar Images. Introduction, data types applicable to GIS, basic equipments and utilities.

Environmental Geology 10

Fundamental concept of Environmental Geology. Environmental hazards caused by earth processes viz., River, Landslide, Volcanoes, Cyclone. Pollution - sediments, ground water, solid waste disposal, radioactive waste, water management. Mineral resources and environment. Environmental impact of mineral development, recycling of resources, land-use planning in relation to engineering projects.

Unit-III: Photogeology and Remote Sensisng 25

Types and acquisition of aerial photograph. Scale and resolution. Black and white, colour and infrared film. Photomosaics. Principles of stereoscopy, lens and mirror stereoscopes, image parallax, relief displacement, vertical exaggeration, distortion. Elements of airphoto interpretation. Identification of sedimentary, igneous and metamorphic rocks. Aeolian, glacial, fluvial and marine landforms. Physical principles of remote sensing. Early history of space imaging. Earth Resources Satellites: Characteristics and applications of imageries of LANDSAT1 to 7, SPOT missions, Indian Remote Sensing Satellite mission. Basic idea of Radar Images.

PRACTICALS

Engineering Geology, Hydrogeology, Photogeology and Remote Sensing 25

Engineering Geology 5

Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures as dam sites and tunnels. Interpretation of geological maps for engineering problems.

Hydrogeology 3

Preparation and interpretation of hydraulic gradient and water table maps.

Photogeology and Remote Sensing 8

Study of aerial photo-pairs using lens and mirror stereoscopes. Calculation of scale from aerial photographs. Preparation of geological drainage maps from photographs. Delineating geomorphic features (aeolian, fluvial, glacial and coastal), rock types (igneous, sedimentary and metamorphic and unconsolidated sediments) and structural features (fold, faults, joints, caverns, lineaments). Recognition of various topographic features from satellite imageries.

Field-Work 5

Visit to mines, mineral deposits and other geologically important areas, type sections, etc.

Viva voce 4

Books Recommended:

Bryant, E., 1985: Natural Hazards, Cambridge Univ. Press.

Davis, S.N. and De Weist, R.J.M., 1966: Hydrogeology, John Wiley & Sons Inc., N.Y.

Drury, S.A., 1987: *Image Interpretation in Geology*. Allen and Unwin.

Gupta, R.P., 1990: *Remote Sensing Geology*. Springer Verlag.

Johnson, R.B. and DeGraf, J.V., 1988: Principles of Engineering Geology, John Wiley.

Karanth, K. R., 1989: Hydrogeology, Tata McGraw Hill Publ.

Kellar, E. A., 2000: Environmental Geology. Prentice Hall, N. Jersey.

Krynin, D.P. and Judd W.R., 1957: Principles of Engineering Geology & Geotechnique, McGrawHill (CBS Publ).

Lillesand, T.M. and Kieffer, R.W., 1987: *Remote Sensing and Image Interpretation*. John Wiley.

Miller, V.C., 1961: *Photogeology*. McGraw Hill

Paine, D.P., 1981: *Aerial photography and Image Interpretation for Resource Management*. John Wiley.

Pandey, S.N., 1987: *Principles and Applications of Photogeology*. Wiley Eastern, New Delhi.

Raghunath, H. M. 1982: Groundwater, Wiley Eastern Ltd., N. Delhi.

Strahler, A.N. and Strahler, A.H., 1973: Environmental Geoscience: interaction between natural systems and man. Hamilton Pub, USA.

Todd, D.K., 1980: Groundwater hydrology, 2nd Ed., John Wiley & Sons,N.Y.

Valdiya, K.S., 1987: Environmental Geology – Indian Context, Tata McGraw Hill.

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

Kellar, E. A. 2000. Environmental Geology. Prentice Hall, N. Jersey.

Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique. McGrawHill (CBS Publ).

Ramachandra Rao and M.B., Prasaranga (1975) Outlines of Geophysical Prospecting - A manual for geologists. University of Mysore, Mysore, 1975.

Raghunath, H. M. 1982. Groundwater, Wiley Eastern Ltd., N. Delhi.

Strahler, A.N. and Strahler, A.H. 1973. (Revised Ed.) Environmental Geoscience: interaction between natural systems and man. Hamilton Pub, USA.

Todd, D.K. 1980. Groundwater hydrology, 2nd Ed., John Wiley & Sons,N.Y.

Valdiya, K.S. (1987): Environmental Geology – Indian Context, Tata McGraw Hill.

MANIPUR UNIVERSITY
CANCHIPUR: IMPHAL

Syllabus for Bachelor of Geology (General/Pass)
(V and VI Semesters)

FIFTH SEMESTER

THEORY

Paper Code	Title	Marks
GL-505:	Economic Geology, Mineral Economics and Mining Geology	75
	Economic Geology	50
	Mineral Economics and Mining Geology	25

PRACTICAL

	Economic Geology, Surveying and Mining Geology	25
	Economic Geology	10
	Surveying and Mining Geology	10
	Viva voce	05

SIXTH SEMESTER

THEORY

Paper Code	Title	Marks
GL-606:	Engineering Geology, Hydrogeology and Environmental Geology, Photogeology and Remote Sensing	75
	Engineering Geology	25
	Hydrogeology and Environmental Geology	25
	Photogeology and Remote Sensing	25

PRACTICAL

	Engineering Geology, Hydrogeology, Photogeology and Remote Sensing, and Field Work	25
	Engineering Geology	05
	Hydrogeology	03
	Photogeology and Remote Sensing	08
	Field Work (1 week)	05
	Viva voce	04

SEMESTER – V

GL-505: ECONOMIC GEOLOGY, MINERAL ECONOMICS AND MINING GEOLOGY **75**

Unit - I and II Economic Geology **50**

Unit-I **25**

Scope of the subject. Definition of ore, ore mineral and gangue. Tenor of ore. Classification of ore deposits. Mineralization and mineral deposits. Concept of syngenetic and epigenetic deposits. Forms and structures of mineral deposits. Brief idea about ore forming processes - magmatic, metasomatic, metamorphic, hydrothermal, placer, residual deposits and oxidation and supergene suphide enrichment. Concepts of metallogenic epoch and province. Paragenesis, paragenetic sequence and zoning in metallic ore deposits.

Unit-II **25**

Study of Indian deposits of the following ores and minerals with reference in their geology, mode of occurrence, distribution, uses of iron, manganese, chromite, lead-zinc, copper, bauxite and mica

Fundamentals of coal petrology, origin of Coal. Stratigraphy of Coal Measures. Overview of Indian coal deposits. Origin of petroleum and natural gas, surface indicators of oil shows, migration of oil, petroleum reservoirs and various types of oil traps. Onshore and off-shore distribution of petroliferous basins in India.

Unit-III Mineral Economics and Mining Geology **25**

Mineral Economics **10**

Study of important industrial minerals of India with particular reference to the industries - cement, glass and ceramics, refractory, fertilizer and building stones, chemicals and gemstones. Significance of minerals in national economy. Demands, supply and substitute of minerals. Resources and reserves, their classification.

Mining Geology **15**

Relationship between geology and mining. Different terms used in mining. Concept of Mining methods - surface mining and alluvial mining, mineral sand, open pit and open cast mining and underground mining. Fundamentals of exploration of mineral deposits.

PRACTICALS

Economic Geology, Surveying and Mining Geology **25**

Economic Geology **10**

Study of ore and economic minerals in hand specimens for the deposits 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.