

SYLLABUS FOR GEOLOGY
UNDER CHOICE BASED CREDIT SYSTEM
(Honours, Regular, GE and SEC)
2016-19

Approved by
The Board of Studies in GEOLOGY 21.9.16



BERHAMPUR UNIVERSITY, BHANJABIHAR
BERHAMPUR 760007; ODISHA, INDIA

Syllabus for B.Sc. Geology(Hons),Six semester Course under CBCS

CORE COURSE STRUCTURE

(2016-17, 17-18, 18-19)

I YEAR

SEMESTER	CC Code/No	TITLE	UNIT	CREDIT
I	CC-1	Earth System Science	U-1 Planet Earth U-2 Geotectonics U-3 Marine Geology U-4 Soil	4
		Practical		2
	CC-2	Mineral Science	U-1 Introduction to Minerals U-2 Rock forming Minerals U-3 Crystallography U-4 Mineral optics	4
		Practical		2
II	CC-3	Elements of Geochemistry	U-1 Concept of Geochemistry U-2 Layered structure of earth and geochemistry U-3 Geochemistry of Solid Earth U-4 Cosmic abundance of element	4
		Practical		2
	CC-4	Structural Geology	U-1 Stress and Strain inRocks U-2 Folds U-3 Joints and Fault U-4 Unconformity, foliation and Lination	4
		Practical		2

II YEAR

SEMESTER	CC Code/No	TITLE	UNIT	CREDIT	
III	CC-5	Igneous Petrology	U-1 Concept of igneous petrology U-2 Forms, Structure and Texture U-3 Phase diagram and petrogenesis U-4 Petrogenesis of igneous rocks	4	
		Practical			
	CC-6	Sedimentology	U-1 Origin of Sediments U-2 Sedimentary Environment U-3 Sedimentary Texture and structure U-4 petrography	4	
		Practical		2	
	CC-7	Palaeontology	U-1 Fossilisation and fossil record U-2 Invertebrates U-3 Paleobotany U-4 Micropalaeontology and Utility of fossils	4	
		Practical		2	
		CC-8	Metamorphic Rocks	U-1 Metamorphism U-2 Facies and grades U-3 Regional and Contact metamorphism U-4 Metamorphic Rocks	4
			Practical		2
		CC-9	Stratigraphy	U-1 principles of stratigraphy U-2 Precambrian Strtigraphy U-3 Phanerozoic Sratigraphy U-4 Sratigraphic Boundaries	4
			Practical		2
CC-10	Hydrogeology	U-1 introduction and basic			

IV			Concept U-2 Ground water Flow U-3 Ground water exploration U-4 ground water management	4
		Practical		2

III YEAR

SEMESTER	CC Code/No	TITLE	UNIT	CREDIT
V	CC-11	Economic Geology	U-1 Ore and Gangue U-2 Processes Of Formation of Ore deposits U-3 Metallic Mineral Deposits In India U-4 Industrial and Atomic Mineral in India	4
		Practical		
	CC-12	Geomorphology	U-1 Introduction to geomorphology U-2 Surficial Processes in geomorphology U-3 land forms and processes U-4 overview of Indian Geomorphology	4
		Practical		2 2
VI	CC-13	Remote Sensing	U-1 Photogeology U-2 Remotesensing U-3 Digital image Processing U-4 Geographical Information system and GPS	4
		Practical		2
	CC-14	Engineering Geology	U-1 Geology vs Engineering U-2 Engineering	4

			Foundation U-3 Rock mechanics U-4 Building Stones	
		Practical		2

GEOLOGY (HONOURS)

SEMESTER – I

Paper CC1 – EARTH SYSTEM SCIENCE (6 Credits)

Unit I: Planet Earth

Introduction to various branches of Earth Sciences. General characteristics and origin of universe , and its Planet. The terrestrial and Jovian planets. Meteorites and Asteroids. Earth in the solar system- Origin ,Size, shape, mass, density, rotational and revolution parameter's and its age. Interior of the Earth- formation of core ,mantle, crust. Convection in Earths core and production of its magnetic field. Mechanical layering of the Earth.

Unit II: Geotectonics

Concept of continental drift, plate tectonics, sea-floor spreading, apostasy.

Earthquake and earthquake belts. Volcanoes - types, products and their distribution.

Unit III: Marine Geology

Tectonic Feature in Ocean: Relief of the ocean floor, Geodynamics ,elements of Earth- Mid oceanic ridges, transform fault, and Island arcs Marine sediments, Coral leaf and Marine Mineral Resources.

Unit IV: Soil

Process of formation of Soils, Soil profile and Soil types

Practical(2credits)

Detail study of topographic sheets and preparation of physiographic description of an area

Study of contour patterns and drawing of profile

Study of seismic profile of a specific area and its interpretation

Suggested Readings

1. P.M.D.DUFF & D.DUFF. Holme's principles of physical geology
2. C.Emiliani.Planet earth:cosmology,geology and the evolution of life and environment.cambridge university press.
3. M.G.Gross.Oceanography: Aview of the Earth
4. A.Dasgupta(2006) An introduction to Earth Science,World Press,Kolkata.
5. G.B.Mahaptra ,A Text Book of Physical geology
6. K.Sddhartha , The Earth's Dynamic Surface ,Kisalaya publication

GEOLOGY (HONOURS)

SEMESTER – I

Paper CC 2 – MINERAL SCIENCE (6 Credits)

Unit I: Introduction to Mineralogy

Minerals – definition and classification, physical properties, Silicate and non-silicate structure (CCP and HCP). Concept of unit cell and space lattice

Unit II: Silicate minerals

Physical ,Chemical and Optical properties of Silicate minerals – Olivine, Pyroxene, Amphibole, Garnet, Felspar, Felspathoid, Silica and Mica and Non-Silicate mineral groups- Carbonate, Phosphate, Sulphate, Oxide

Unit III: Crystallography

Elementary idea s about crystal morphology in relation to internal structures, crystal parameters and indices, crystal symmetry and classification of crystals into six systems,stereographic projections of symmetry elements and forms, twinning .

Unit IV: Mineral Optics

Nature of light and principles of optical mineralogy-Isotropism, Double refraction, Polarisation Anisotropism, Pleochroism, Interference colour, birefringence, Optic axis, Accessory plate, ,Extinction, Exinction angle,Uniaxial Interference figure, Optic Sign, Introduction to the Nicol Prism-construction, principles and uses. petrological microscope and identification of common rock forming minerals.

Practical(2credits)

Study and identification of crystal models

Stereographic projection of crystal models

Megascopic identification of rock forming minerals as given in theory

Microscopic identification of rock forming minerals

Measurement of extinction angle and order of interference colour

SUGGESTED READING:

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

GEOLOGY (HONOURS)**SEMESTER – II****Paper CC 3–Elements of Geochemistry (6 Credits)****UNIT 1: Concept of Geochemistry**

Introduction to properties of elements: The Periodic table,Chemical bonding,states of matter and atomic environment of elements,geochemical classification of elements.

UNIT-2: Layered Structure Of Earth And Geochemistry

Composition of different Earth reservoirs and nuclides and radioactivity,conservation of mass,isotopic and elemental fractionation , concept of radiogenic isotopes in geochronology and isotopic tracers.

UNIT 3: Element transport

Advection and diffusion; Chromatography,Aqueous geochemistry-basic concept and speciation in solution,Eh,PH,relations Elements of marine chemistry, mineral reactions – diagenesis and hydrothermal reactions.

UNIT 4: Geochemistry of solid Earth

The solid earth-geochemical variability of magma and its products,the earth in the solar system, the formation of solar system,composition of bulk silicate Earth , Meteorites.

Practical (Credit 2)

Types of geochemical data analysis and interpretation of common geochemical plots.
Geochemical analysis of geological samples.

SUGGESTED READINGS:

- 1.B.Mason, Principles of Geochemistry.3 rd edition,Wiley New York
- 2.H.Rollinson , Using geochemical data-evaluation ,presentation and interpretation.2nd edition.Publisher Longman Scientific & Technical.
- 3.J.V.Walther, Essentials Of geochemistry . Jones & Bartlett publisher.
- 4.F.Albarede.Geochemistry :an introduction.Cambridge University press.
- 5.Faure, Gunter and Teresa .Mensing.Isotopes :Principles and Application ,Wiley India pvt ltd.

GEOLOGY (HONOURS)

SEMESTER – II

Paper CC 4– STRUCTURAL GEOLOGY (6 Credits)

UNIT 1: Structure and Topography

Effects of topography on structural features, Topographic and structural maps; Importance representative factors of the map

UNIT 2: Stress and Strain in rocks

Concept of rock deformation :stress and strain in rocks , strain ellipses of different types and their geological significance. Planar and linear structures ; Concept of dip and strike ; Outcrop patterns of different structures.

UNIT 3: Folds ,Faults and Joints

Fold morphology; Geometric and genetic classification of fold ; Introduction to the mechanics of folding: Buckling , Bending, Flexure slip and flow folding, Types of joints. Geometric and genetic classification of faults. Effects of faulting on the outcrops. Geologic/geomorphic criteria for recognition of faults and fault plane solutions.

UNIT 4: Unconformities, Foliation and Lineation

Unconformities : types and recognition in the field , Description and origin of foliation : axial plane cleavage and its tectonic significance. Description and origin of lineation and relationship with the major structures.

Practical (Credit 2)

Basic idea of topographic contours. Topographic sheets of various scales. Introduction to geological maps: Lithological and Structural maps, Structural contouring and 3-point problems of dip and strike. Drawing profile sections and interpretation of geological maps of different

SUGGESTED READINGS:

1. G.R. Davis, Structural Geology Rocks and Region, John Wiley
2. Billing M.P. Structural Geology, 4th edition, Prentice Hall
3. Park R.G. (2004) Foundation 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 technique (4th Ed) Cambridge University Press (for practical)
6. Lahee F.H. (1962) field geology. McGraw hill

GEOLOGY (HONOURS)

Semestar III

Paper CC 05- IGNEOUS PETROLOGY(6 Credits)

UNIT 1: Concept of igneous petrology

Introduction to petrology: heat flow, geothermal gradients through time, origin and nature of magma.

UNIT 2: Forms of igneous rocks

Classification of igneous rocks ; textures and structures of igneous rocks, Mode of occurrence of igneous rocks.

Unit 3: Phase diagrams and petrogenesis

Binary and Ternary Phase diagrams in understanding crystal –melt equilibrium in basaltic and granitic magmas; Magma generation in crust and mantle, their emplacement evolution

UNIT 4: Petrogenesis of Igneous rocks

Petrogenesis of Felsic and Mafic igneous rocks; Komatites, Granitoids, Basalt and Gabbros, Alkaline rocks, Kimberlites and lamproites

PRACTICAL(Credit 2)

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

SUGGESTED READINGS

1. A.Philpots & J.Ague.Principles of igneous and metamorphic petrology.Cambridge University Press.
2. J.D.Winter.Principles of igneous and metamorphic petrology.Pearson.
3. H.R.Rollinson.Using geochemical data:evaluation,presentation,interpretation.Routledge.
4. L.A.Raymond.Petrology:the study of igneous ,sedimentary and metamorphic rocks.McGraw-Hill Science Engineering.
5. A.R.McBirney.Igneous petrology.San Francisco and Oxford.
6. G.Best .Myron.Igneous and metamorphic petrology,
7. K.G.Cox,J.D.Bell.The interpretation of Igneous rocks.Springer\Chapman& Hall.

8 M.K.Bose.Igneous petrology.9.G.W.Tyrrell.Principles of Petrology

GEOLOGY (HONOUS)

SEMESTER III CORE COURSE

Paper CC 06 –SEDIMENTARY PETROLOGY (6 Credits)

UNIT 1: Origin of sediments

Introduction,formation of sediments and sedimentary rocks.Elementary idea on sedimentary environments.

UNIT 2: Sedimentary environment.

,Paleocurrent analysis –Paleocurrent for different sedimentary environments.Heavy minerals and provenance.Sedimentary basins of India.

UNIT 3: Sedimentary textures,structures

Texture,structure and diagenesis of sedimentary rocks.Elementary idea on sedimentary facies.Classification of sedimentary rocks.

UNIT 4:Petrography

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

PRACTICAL (Credit 2)

Exercise on sedimentary structures.Paleocurrent analysis
Petrography of clastic and non-clastic rocks through hand specimens and thin sections.

SUGGESTED READINGS:

1. D.R.Prothero &F.Schwab,Sedimentary geology.Macmillan.
2. M.E.Tucker,Sedimentary Petrology,Blackwell Publishing.
3. J.D.Collinson & D.B.Thompson ,Sedimentary structures,Unwin-Hyman,London
4. G.Nichols,Sedimentology and Stratigraphy Second Edition.Wiley Blackwell.

GEOLOGY (HONOURS)**SEMISTER III****CORE COURSE****Paper CC 7 –PALAEOLOGY (6 Credits)****UNIT-1: Fossilization and fossil record**

Nature and importance of fossil record ;Fossilization and modes of preservation

UNIT -2:Invertebrates

Brief introduction to important invertebrate groups (Bivalvia,Mollusca,Brachiopoda) and their biostratigraphic significance,Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications, Functional adaptation in trilobites and ammonoids.

UNIT-3:Palaeobotany

Introduction to Palaeobotany, Gondwana Flora, Introduction to Ichnology.

UNIT-4: Micropalaeontology and Utility of Fossils

Introduction to Micro Palaeontology, Morphology of Foraminifera and its environmental significance. Application of fossil in Stratigraphy Biozones,index fossils,correlation,Role of fossil in sequence stratigraphy Fossil and paleo environmental analysis, Fossils and paleobiogeography,biogeographic provinces, dispersal and barriers paleoecology fossils as a window to the evolution of ecosystems.

PRACTICAL(Credit 2)

Study of fossils showing various modes of preservation, Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, and plant fossils as given in theory.

SUGGESTED READINGS

1. D.M.Raup,S.M. Stanley,W.H.Freeman,Principles of Paleontology
2. E.N.K.Clarkson,Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing.
3. M.Benton,Vertebrate paleontology.John Wiley & Sons.
4. A.C.Shukla & S.P.Misra,Essentials of paleobotany,Vikash PublisherH.A.Armstrong & M.D.Brasier,Microfossils.Blackwell Publishing

GEOLOGY (Honours)

Semester IV

Core Course

Paper CC-8 METAMORPHIC PETROLOGY (6 Credits)

Unit 1: Metamorphism: Controls and types

Defination of metamorphism. Factors controlling metamorphism, Types of metamorphism – contact, regional, fault zone metamorphism, impact metamorphism.

Unit II: Metamorphic facies and grades

Index minerals, Chemographic projections, Metamorphic zones and isogrades, Concept of metamorphic facies and grades, Mineralogical phase rule of closed and open system, Structures and textures of metamorphic rocks.

Unit III:Regional and Contact Metamorphism

Regional and contact metamorphism of argillaceous, arenaceous and carbonate rocks.

UNIT 4: Metamorphic rock associations –

Schists, gneisses, khondalites, charnockites, blue schists and eclogites.

Practical (Credit 2)

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, amphibolites, hornfels, garnetiferous schist, Sillimanite-Kyanite –bearing rocks, Granulites, eclogites, marbles

SUGGESTED READINGS:

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

GEOLOGY (Honours)

SEMESTER IV

CORE COURSE

PAPER CC9 –STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY(6 Credits)

UNIT 1: Principles of Stratigraphy

Fundamentals of litho , bio and chrono –stratigraphy. Introduction to concepts of dynamic stratigraphy(chemostratigraphy, seismic stratigraphy, sequence stratigraphy)

UNIT 2 :Physiographic and tectonic subdivisions of India

Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian shield. Introduction to Proterozoic basins of India. Geology of Vindhyan and Cuddapah basins of India.

UNIT 3:Paleozoic and Mesozoic stratigraphy

Paleozoic succession of Kashmir and its correlatives from Spiti and Zaskar. Stratigraphy structure and hydrocarbon potential of Gondwana basins. Mesozoic stratigraphy of India:

a. Triassic succession of Spiti, b. Jurassic of Kutch, c. Cretaceous succession of Trichinopoly

UNIT 4: CENOZOIC STRATIGRAPHY OF INDIA:

a. Kutch basin , b. Siwalik successions, c. Assam, Andaman and Arakan basins.

Stratigraphy & structure of Krishna- Godavari basin , Bombay offshore basin , Kutch & Saurashtra basins & their potential for hydrocarbon exploration. Stratigraphic boundaries –a. Precambrian –Cambrian boundary, b. Permian-Triassic boundary , c. Cretaceous –Tertiary boundary

Palaeogeography of Indian Subcontinent during Permo-Carboniferous, Triassic, Jurassic and Cretaceous Period

Practical (Credit 2)

Study of geological map of India and Odisha and identification of major stratigraphic units and their drawing. Drawing of Palaeogeographic maps mentioned in theory.

Study of rocks in hand specimens from known Indian stratigraphic horizon.

SUGGESTED READINGS;

1. Krishnan, M.S. (1982) Geology of India & Burma, CBS publishers, Delhi
2. Doyle, P. & Bennett, M.R. (1996) Unlocking the stratigraphy 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.

GEOLOGY (HONORS)**SEMESTAR – IV****Core Course****Paper –CC 10 –HYDROGEOLOGY (6 credits)****UNIT -1: introduction & basic concepts**

scope of hydrogeology & its societal relevance. hydrologic cycle : precipitation, evapo-transpiration, run-off, infiltration & subsurface movement of water. rock properties affecting ground water, vertical distribution of subsurface water. types of aquifer, aquifer parameters, anisotropy & heterogeneity of aquifers. Physical and chemical properties of water and water quality.

UNIT –II : Groundwater flow

Darcy's law & its validity. intrinsic permeability & hydraulic conductivity. ground water flow rates & flow direction. laminar & turbulent groundwater flow.

UNIT –III: Well hydraulics & ground water exploration

Basic concepts (draw down, specific capacity etc). elementary concepts related to equilibrium and non equilibrium condition for water flow to a well in confined & unconfined aquifers

.surface –based groundwater exploration methods .introduction to surface borehole logging methods .

UNIT –IV: Groundwater management

Surface & subsurface water interaction groundwater level fluctuations. Basic concepts of water balance studies ,issues related to groundwater resources development & management ,rainwater harvesting & artificial recharge of groundwater .

Practical:Credit 2 (Mark 25)

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

Study and preparation and analysis of hydrographs for differing groundwater conditions

Water potential zones of India(map study).

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

Simple numerical problems related to determination of permeability in field and laboratory. Ground water flow. Well hydraulics etc.

SUGGESTED READINGS :

- 1.Todd ,D.K (2006) .groundwater hydrology ,2nd Ed ,john wiley & sons , N.Y
- 2.Davis ,S.N & De Weist ,R.J.M (1966) hydrogeology ,john wiley & sons inc , N.Y
- 3.Karant K.R (1987)groundwater : assessment , development & management , tata Mc Grawhill pub.co.ltd

GEOLOGY (HONOURS)

SEMESTER – V

Paper CC11 – ECONOMIC GEOLOGY(6 Credits)

Unit I: Ores and gangues

Ores, gangue minerals, tenor, grade and lodes. Resource and reserves, Metallogenic epoch and provinces of India

Unit II: Process of Formation of Ore Deposits

Endogenous process: magmatic concentration, skarns, greisens, and hydrothermal deposits

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

Unit III: Metallic mineral deposits of india

Important deposits of India-Iron, Manganese, bauxite, Chromite, copper, Lead, and Zinc

Unit IV: Industrial Minerals and atomic Minerals

Mode of occurrence, and distribution of minerals required(Raw materials) for Refractory and Cement industries.

Atomic Minerals: uranium, thorium

Practical (Credit 2)

Megascopic identification ,study of microscopic properties of ore forming mineral (oxides & sulphides).Preparation of maps;distribution of important ore and other economic minerals in india.

Suggested Readings:

1. Guilbert J.M. and Park Jr., C.F.(1986) The Geology of Ore deposits. Freeman & Co
2. Batman A.M. and Jensen M.L. (1990) Economic Mineral Deposit John Wiley
3. Evans A.M. (1993) Ore geology of 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 Metllogeny in India, Cambridge publication

GEOLOGY (HONOURS)

SEMESTER – V

Paper CC12 – Geomorphology (6 Credits)

Unit I: Introduction to Geomorphology

Introduction, Major Morphological Features, Topography, Geod, Hypsometry, Global Hypsometry.

Unit II : Surficial Processes and geomorphology

Surficial Processes and geomorphology. Weathering and associated landforms. Hill slopes, Glacial,Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and land forms, CoastalProcesses and land forms, Krast landforms.

UNIT III: Land forms and processes

Endogenic –exogenic interactions, rates of uplift and denudation ,tectonics and drainage development ,sea level change,long –term landscape development.Landforms associated with igneous activities.

UNIT IV: Overview of Indian Geomorphology

Overview of Indian Geomorphology extraterrestrial landforms.

Practical (Credit 2) Mark 25

Reading photographic maps, concept of a scale, preparation of a photographic profile, preparation of longitudinal profile of a river, preparing hack profile, calculating stream length gradient index, morphometry of a drainage basin, calculating different morphometric parameter. preparation of geomorphic map, interpretation of geomorphic processes from geomorphology of the area.

SUGGESTED READINGS:

1. S. Robert, Anderson and P. Suzzane, :Geomorphology-The Mechanics and Chemistry of Landscape. Cambridge University Press.
2. M.A. Summerfield, Global Geomorphology. Wiley & SONS.

GEOLOGY (Honours)

Semester VI

Paper C13-REMOTE SENSING AND GIS (6 Credits)

Unit-1: Photogeology

Types and acquisition of aerial photographs; Scale and Resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion

Elements of air photo interpretation

Identification of sedimentary, igneous and metamorphic rocks and various Aeolian, glacial fluvial and marine landforms

Unit II : Remote Sensing

Concepts in Remote Sensing

Sensors and scanners

Satellites and their characteristics

Data Formats- Raster and Vector

Unit III : Digital Image Processing

Digital image processing, Image Errors, Rectification and Restoration, FCC, Image Enhancement, Filtering, Image Rationing, Image Classification and Accuracy assessment. GIS integration and Case studies-Indian Examples

Unit IV : Geographical Information System and GPS

GIS, Datum, Coordinate systems and Projection Systems Spatial data models and data editing

Introduction to DEM analysis. Concept and application in geology of GPS. Integrating GPS data with GIS

PRACTICALS (Credit2)

Aerial photo interpretation, Identification of sedimentary , Igneous and metamorphic rock and various Aeolian, Glacial, Fluvial and marine Landforms

Introduction to DIP and GIS softwares. Digital image Processing exercises including analysis of satellites 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 it's interpretation classification of images. DEM analysis: Generating slope map, aspect map and drainage network map and it's applications

SUGGESTED READINGS :

1. Demers, M.N., 1997. Fundamentals of Geography information System, John Wiley and Sons. Inc.
2. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. GPS: Theory and Practice, Springer Wien New York.
3. Jensen, J.R., 1996. Introductory Digital Image Processing: A Remote Sensing Perspective, Springer- Verlag.
4. Lillesand, T.M. and 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. S.N. Pandey, Principles and applications of PHOTOGEOLOGY,Wiley Eastern Ltd..
7. G.S. Srivastava to Geoinformatics.McGraw Hill

GEOLOGY (Honours)

Semester VI

Core Course

Paper C14-Engineering Geology (6 Credits)

Unit-I : Geology vs. Engineering

Role of engineering geologists in planning, design and construction of major man-made structural features, Site investigation and characterization

Unit-II : Engineering Foundation

Foundation treatment; Grouting, Rock Bolting and other support mechanisms

Unit-III : Building Stones

Intact rock and Rock mass properties of building stones, Concrete aggregates and road metals and their significance as Construction Material

Unit-IV : Rock Mechanics

Concept, Mechanism and significance of rock quality Designation (**RQD**)

Concept, Mechanism and significance of :

- a. Rock Structure Rating (**RSR**)
- b. Rock Mass Rating (**RMR**)
- c. Tunneling quality index (**Q**)

Geological, geotechnical and Environmental Consideration for Dams and Reservoirs

PRACTICALS (Credit 2)

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Merits, Demerits and Remedial measures based upon Geological cross sections of project sites.
3. Computation of Index properties of Rocks.
4. Computation of RQD,RSR,RMR and 'Q'

SUGGESTED READINGS :

1. Krynin, D.P and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
2. Johnson, R.B and De Graf, J.V 1988. Principles of Engineering Geology, John Wiley.
3. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering Constructios. John Wiley and Sons, N.Y.
4. Waltham, T., 2009. Foundations of Engineering Geology (3rdEdn.) Taylor and Francies.
5. Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
6. Bell: F.G-, 2007. Engineering Geology , Butterworth-Heineman

Discipline Specific Elective**III YEAR**

SEMESTER	DSE Code/No	TITLE	UNIT	CREDIT
V	DSE-1	Exploration Geology	U-1 Prospecting and exploration U-2 Evaluation of data U-3 drilling and logging U-4 Rersrve estimation	6
	DSE-2	Fuel Geology	U-1 Coal U-2 Petroleum U-3 Petroleum reservoir and Traps U-4 other Fuels	6

VI	DSE-3	Climate Change and disaster management	U-1 Natural disasters and management U-2 managing Geohazards U-3 Elements of Climetology U-4 climate Change	6
	DSE-4	<u>PROJECT</u> OR <u>Evolution of life through time</u>	Identification of problem Review of Literature Methodology Finding Analysis Viva voce OR U-1 Life through ages U-2 Origin of Life U-3 Phanerozoic life U-4 The age of humans	6

Discipline specific elective course include discussion on topics determined students in tutorial and there should be student presentation apart from the lectures. The topics would be assigned to the students based on their interest

GEOLOGY (HONOURS)

SEMESTER – VI

DISCILINE SPECIFIC ELECTIVE

Paper DSE 1– EXPLORATION GEOLOGY (6 Credits)

UNIT 1: Prospectining and exploration

Principles of mineral exploratilon , prospecting and exploratilon(physical & geological)- conceptualization, methodology and stages , sampling,sub surface sampling including pitting , trenches and drilling. Geochemical exploration

Unit 2: Evaluation of data

Evaluation of sampling data , mean,mode,median,standard deviation and variance

Unit 3:Drilling & Logging

Core and Non-core drilling,Planning of Bore holes and locations of bore holes on ground core- logging

unit 4: Reserve estimation and errors

Principle of reserve of estimation, density and bulk density Factor affecting reliability of reserve estimation Reserve estimation based on geometrical Model (Square,rectangular,triangular and polygon block) regular and irregular grid patterns,statistic and error estimation

Suggested readings:

1. G.B Clark . elements of mining 3rd Ed John Willey & Sons
2. R.P.N Arogyaswamy Courses in mining Geology .4th Ed Oxford-IBH
3. C.J Moon,M.K.G .Evans . introduction to mineral exploration, Blackwell Publishing.

GEOLOGY (HONOURS)

SEMESTER – VI

DISCIPLINE SPECIFIC ELECTIVE

Paper DSE 2 – FUEL GEOLOGY (6 Credits)

UNIT 1: Coal

Definition and origin of coal basic classification of coal.Fundamentals of coal petrology-introduction to litho types,micro litho types and macerals in coal,proximate and ultimate analysis.

UNIT 2:Coal as a fuel

Coal bed methane (CBM):global and Indian scenario,underground coal gasification,coal liquefaction

UNIT 3: Petroleum

Chemical composition and physical properties of crudes in nature,origin of petroleum, maturation of kerogen; Biogenic and Thermal effect

UNIT 4: Petroleum reservoirs and traps

Reservoir rocks:general attributes and petrophysical properties.classification of reservoir rocks-clastic and chemical.Hydrocarbon traps:definition,anticlinal theory and trap theory.classification of hydrocarbon traps-structural,stratigraphic and combination. Time of trap formation and time of hydrocarbon accumulation .cap rocks –definition and general properties.Plate tectonics and global distribution of hydrocarbon reserves.

SUGGESTED READINGS:

1. D.Chandra,Chandra's Textbook on applied coal petrology.Jijnasa publishing House.
2. R.C.Shelly.Element of petroleum Geology; Third edition , Academic Press
3. K.Bjorlykke.Sedimentology and petroleum geology,springre –Verlag
4. R.Bastia & M.Radhakrushna ,Basin evolution and petroleum prospectivity of the continental margin of India VOL.59.Newnes.

GEOLOGY (HONOURS)**SEMESTER – VI****DISCIPLINE SPECIFIC ELECTIVE****Paper DSE 3 – CLIMATE CHANGE AND DISASTER MANAGEMENT(6 Credits)****Unit I: Natural Disaster and management**

Drought,Flood,Cyclone,Tornado, Thunder Storm,

Unit II: Managing Geohazards

Earthquake,Land slide, Tsunami, Inundation of coastline

Unit III: World Weather Circulation

Thermal Structure &Composition of Atmosphere, Elements of Climate and weather. Jet stream and its influence on world weather; Air Mass, their classification and influence on world weather; Fronts (Front classification)

Unit IV: Climate Change

Glacial periods, sea-level rise, effects of sea level rise, Rise of carbon dioxide in the atmosphere, green house gases, green house effect and global warming, Desertification

Suggested readings

1. Bell, F.G.(1999). Geological Hazards , Routledge, London.
2. Bryant, E.,(1985). Natural Hazards, Cambridge University Press.

- Smith, K. (1992). Environmental Hazards. Routledge, London.

GEOLOGY (HONOURS)

SEMESTER – VI

DISCIPLINE SPECIFIC ELECTIVE

Paper DSE 4– EVOLUTION OF LIFE THROUGH TIME (6 Credits)

Unit 1: Life through ages

Fossils and chemical remains of ancient life, geological time scale with emphasis on major bio-events, biogeochemical cycles, abundance and diversity of microbes, extremophiles, microbes – mineral interactions, microbial mats.

UNIT 2: Origin of life.

Possible life sustaining sites in the solar system, Archean life: Earth's oldest life, transition from Archean to Proterozoic, the oxygen revolution and radiation of life, Precambrian microfossils- The garden of Ediacara, the snow ball earth hypothesis.

UNIT 3: Phanerozoic

Paleozoic; The Cambrian explosion, biomineralisation and skeletalisation, origin of vertebrates and radiation of fishes, origin of tetrapods- life out of water, early land plants and impact of land vegetation. **Mesozoic life**; 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. **Cenozoic life**; Aftermath of end Cretaceous mass extinction- radiation of placental mammals, rise of modern plants and vegetation.

UNIT 4: The age of humans

Hominid dispersals and climate setting, climate change during the Phanerozoic- continental break-ups and collisions, plate tectonics and its effects on climate and life.

SUGGESTED READINGS:

- S.M. Stanley, Earth system history.
- I. Jonathan. Lumine. W.H. Freeman, Earth – evolution of a Habitable World, Cambridge University press
- D.E. Canfield & K.O. Konhauser, Fundamentals of Geobiology Blackwell.
- R. Cowen. History of life, Blackwell.

GEOLOGY (HONOURS)
SEMESTER – VI
DISCIPLINE SPECIFIC ELECTIVE
Paper DSE 4– PROJECT (6 Credits)

<u>End Semester Evaluation</u>	<u>MARK</u>
Identification of problem	10
Review of Literature	10
Methodology	10
Finding	20
Analysis	25
Viva voce	25

For DSE 4 a student have a choice for opting either a project work or the theory paper as mentioned. The project work evaluation shall be done at the time of end semester examination by external examiner

Syllabus for B.Sc. Geology(General),Six semester Course under CBCS

DISCIPLINE CORE COURSE STRUCTURE

(2016-17, 17-18, 18-19)

I YEAR

SEMISTER	DCC	TITLE	Unit	Credit
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	Code/No			
I	DCC-1	Physical & Structural Geology	U-1 Physical Geology(A) U-2 Physical Geology(B) U-3 Structural Geology(A) U-4 Structural Geology(B)	4
	Practical			2
II	DCC-2	Crystallography & Mineralogy	U-1 Crystallography(A) U-2 Crystallography(B) U-3 Mineralogy U-4 optical Mineralogy	4
	Practical			2
III	DCC-3	Petrology	U-1 Igneous Petrology U-2 Sedimentary Petrology U-3 Metamorphology U-4 Petrography	4
	Practical			2
IV	DCC-4	Stratigraphy & palaeontology	U-1 Stratigraphy U-2 Pre & Post cambrian Stratigraphy U-3 Palaeontology(A) U-4 Palaeontology(B)	4
	Practical			2

III YEAR Discipline Specific Elective In Geology

SEMISTER	DCE Code/No	TITLE	Unit	Credit
V	DSE-A	Economic Geology & Hydrogeology	U-1 Economic Geology U-2 metallic Mineral Resources U-3 Non Metallic Mineral Resources U-4 Geology of Odisha	4
	Practical			2
VI	DSE-B	Elements of Applied Geology	U-1 Hydrogeology U-2 Mineral Exploration U-3 Remote Sensing U-4 Engineering Geology	4

	Practical			2
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GEOLOGY (General)

Semester I

Core Course

Paper CC1: Physical & Structural Geology (6 Credits)

UNIT 1: Physical Geology (A)

Scope and subdivision of geology, age and origin of the earth , earthquakes and volcanoes.

UNIT 2: Physical Geology (B)

Processes of weathering and erosion, geomorphic agents, geological action of running water, wind and glacier.

UNIT 3: Structural Geology (A)

Attitude of beds-strike and dip, concept of structural geology,foliation,its relation with major structure.

UNIT 4: Structural Geology (B)

Geometry and classification of fold,fault and joints,Types and geological significance of unconformities.

PRACTICAL: (2 Credits)

Drawing of Geological Sections and interpretation of structures from Geological maps. Completion of out crops.

SUGGESTED READINGS

1. Arthur Holmes,Principles of physical geology.Chapman and Hall,London
2. Miller,An introduction to physical geology.East west pres ltd.
3. E.V.Spencer. Basic concepts of Physical Geology.Oxford and IBH.
4. G.B.Mahapatra,A text book of Physical geology.CBS publishers.
5. M.P.Billings.Structural geology.Printice Hall.
6. G.R.Davis,Structural geology of rocks and region.John Wiley.
7. E.S.Hills,Elements of structural geology.Farriod and Son,London.
8. R.O.Singh.Structural geology,A practical approach.Ganga kaveri publ.,Varanasi

GEOLOGY (General)**Semester II****Core Course****Paper CC2: Crystallography & Mineralogy (6 Credits)**

UNIT 1: Crystallography (A)

Crystalline and non crystalline substances, crystallographic axes, symmetry elements, parameters, indices, twinning, stereographic projections

Unit 2: Crystallography (B)

Classification of crystals, study of normal class of six systems.

UNIT 3: Mineralogy

Definition of minerals and their classification, physical properties of minerals, study of important rock forming minerals, quartz, orthoclase, microcline, plagioclase, hornblende, muscovite, biotite, olivine, garnet, kyanite, silimanite, baryte, tourmaline, topaz, calcite, talc, gypsum, apatite, galena, pyrite, chalcopyrite, chromite, bauxite, .

UNIT 4: Optical mineralogy

Nature of light and their propagation. Double refraction, polarization, Nicol prism, optic axis, behavior of light in mineral thin section, parts of petrological microscope. Study of optical properties of thin section under microscope.

PRACTICAL: (2 Credits)

1. Study and identification of crystal models of Normal classes of Cubic, Tetragonal, Hexagonal, Orthorhombic.
2. Megascopic identification important Rock forming minerals.
3. Study of optical characters of rock forming minerals in thin section.

SUGGESTED READINGS

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

GEOLOGY (General)**Semester III****Core Course**

Paper CC3: Petrology (6 Credits)

UNIT 1: Igneous petrology

Form, texture, structure and classification of igneous rocks, concept of magma.

UNIT 2: Sedimentary petrology

Sediments and sedimentary rocks, texture, structure and classification of sedimentary rocks.

UNIT 3: Metamorphic rocks

Metamorphism, agents and types of metamorphism, texture and structure of metamorphic rocks.

UNIT 4: Petrography

Describe different characters of following igneous, sedimentary and metamorphic rocks

Granite, pegmatite, syenite, basalt, dolerite, gabbro, conglomerate, breccias, shale, sandstone, gneiss, slate, marble, quartzite, schist.

PRACTICAL: (2 Credits) Mark End Sem 25

1. Megascopic & Microscopic identification of rocks as in theory.
2. Field study: Visit to local Geological Outcrops for 2 days to study lithology, structures, & geomorphology followed by report writing.

SUGGESTED READINGS

1. A. Philpotts & J. Ague. Principles of igneous and metamorphic petrology. Cambridge University Press.
2. J. D. Winter. Principles of igneous and metamorphic petrology. Pearson
3. M. K. Bose. Igneous petrology.
4. G. W. Tyrrell. Principles of Petrology

GEOLOGY (General)

Semester IV

Core Course

Paper CC4: Stratigraphy & Palaeontology (6 Credits)

UNIT 1: Stratigraphy

Principles of stratigraphy, standard stratigraphic time scale and its Indian equivalence . stratigraphic correlation. physiographic and tectonic division of India.

UNIT 2: Pre and Post Cambrian Stratigraphy

Achaean formation of India , Karnataka, Rajasthan, Bihar and Odisha, type area of Cuddapah and Vindhyan, Gondwana formation of India, Triassic of spiti, Jurassic of kutch and cretaceous of Trichinopoly, geology of odisha.

UNIT 3: Palaeontology (A)

Definition of fossils, fossils and fossilization, uses of fossils, morphologic study of Brachiopoda, Pelecypoda, Gastropoda Cephalopoda.

UNIT 4: Palaeontology (B)

Murex, conus, pectene, products, Teribratula, Arca, Turitela, Nautilus, Glossopteris, Gangomopteris and Ptillophyllum.

PRACTICAL: (2 Credits)

1. Study, Identification, drawing, labeling of the invertebrate & plant fossils.
2. Study of Geological map of India & identification of major stratigraphy units.
3. Study of rocks in hand specimens from Easternghat group.

SUGGESTED READING

1. Out line of palaeontology, Swinerton
2. Henry Woods, Palaeontology invertebrate. CBS publishers
3. Dr. P.C.Jain, Dr.M.S.Anantharaman. Palaeontology evolution and animal distribution. Vishal publishing.
4. M.S.Krishnan , Geology of India and Burma. CBS Publisher.

GEOLOGY (GENERAL)

Semester V

DISCIPLINE SPECIFIC ELECTIVE (DSE)

Paper 1: Economic Geology & Hydrogeology (6 Credits)

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UNIT 1: Economic Geology (Processes of formation of mineral deposits)

Concepts of ore, tenor, gangue, processes of formation of mineral deposits. Magmatic concentration, hydrothermal deposits, oxidation and supergene sulphide enrichment.

UNIT 2: (Metallic mineral resources)

Mode and occurrence, genesis, uses and Indian distribution of following minerals

Iron, Manganese, Chromium, Aluminium, Lead & zinc.

UNIT 3: Non-metallic mineral resources

Raw materials for cement and refractory industries and their Indian distribution, coal and petroleum.

UNIT 4: Geology of Odisha

Structure, Stratigraphy and economical mineral resources of Odisha.

PRACTICAL: (2 Credits)

1. Identification of Ore & Industrial minerals.
2. Preparation of maps: Distribution of important ores and other economic minerals in India.

SUGGESTED READINGS:

1. Guilbert J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co
2. Batman A.M. and Jensen M.L. (1990) Economic Mineral Deposit John Wiley
3. Evans A.M. (1993) Ore geology of 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 publication

GEOLOGY (GENERAL)**Semester V I****DISCIPLINE SPECIFIC ELECTIVE (DSE)****Paper 2: Elements of Applied Geology (6 Credits)**

UNIT 1: Hydrology

Hydrologic cycle, hydrological properties of rocks as porosity, permeability, vertical; zonation of ground water, aquifuge, aquitard, aquiclude and aquifer, types of aquifer, ground water province of India.

UNIT 2: Mineral Exploration

Principles of mineral exploration, geological and geophysical prospectings of mineral deposits. sampling, assaying and concepts of mining.

UNIT 3: Remote sensing

Types and acquisition of aerial photographs; scale and resolution; principles of stereoscopy, relief displacement, vertical exaggeration and distortion, elements of air photo interpretation. identification of sedimentary, igneous and metamorphic rocks and various Aeolian, glacial, fluvial and marine landforms. concepts in remote sensing, sensors and scanners, satellites and their characteristics, data formats-raster and vector.

UNIT 4: Engineering Geology

Scope of engineering geology, geology of reservoirs and dams. building stones and road materials. social erosion and conservation.

PRACTICAL: (2 Credits)

1. Interpretation of Geological map from dam site.
2. Study of distribution of major dam of India.
3. Ground water problems related to calculation of coefficient of permeability & seepage velocity.
4. Aerial photo interpretation, Identification of Igneous, sedimentary, metamorphic rocks & various Aeolian, & fluvial landforms.

SUGGESTED READINGS:

1. D.K. Todd, Ground water hydrology, John Wiley & Sons.
2. K.R. Karanth, Ground water; Assessment, Development and management, Tata McGraw-Hill pub. co. Ltd.
3. D.K. Banerjee, Mineral Resources of India.

Generic Elective for other Hons Students

Semester	Paper Code	Title	units	Credits
I	Ge 1	Essentials of Geology	U1 General Geology U2 Mineralogy U3 Petrology U4 structure, Fossil and Stratigraphy	4
		PRACTICAL		2
II	Ge 2	Economic and Applied Geology	U1 Economic geology U2 Hydrogeology U3 Engineering Geology U4 Mineral Prospecting	4
		PRACTICAL		2

GEOLOGY

Semester I

Generic Elective Course

Paper GE1-ESSENTIALS OF GEOLOGY (6 Credits)

UNIT-1: General Geology

Introduction to geology, Scope, sub-disciplines and relationship with other branches of science. Origin of earth, internal structure of the earth, Earthquakes, Volcanoes, Concept of plate tectonic. Weathering and it's type, Geological work of running water.

UNIT-II: Mineralogy

Mineral - Definition, Physical properties of mineral, Chemical composition and Physical properties of quartz, Orthoclase, Microcline, Plagioclase, Olivine, Garnet, Muscovite, Biotite, Augite, Hornblende, Talc, Gypsum, Fluorite, Corundum, Tourmaline, Beryl, Calcite

UNIT-III: Petrology

Brief idea about mode of formation of igneous, Sedimentary and Metamorphic rock, Texture and Structure of igneous rock, Sedimentary and Metamorphic Rocks. Petrography notes on Granite, pegmatite, Gabbro, Dolerite Basalt, Sandstone, Limestone, Shale, Conglomerate, Schist, Gneiss, Marble, Slate, Khondalite, Charnockite.

UNIT-IV: Structure, Fossil and Stratigraphy

Sratification and its attitude, Types of fold, fault and unconformity. Definition of fossil, Mode of preservation of fossil, Uses of Fossil, Study of important fossils (Glossopteris, Gangamopteris, Ptilophyllum, Arca, Terebratula, Pecten, Physa, Murex, Nautilus), Geological time scale, Principle of Stratigraphy, Physiography division of India, Eastern Ghat Group, Gondwana Super Group

PRACTICAL(Credt 2): Megascopic identification of rock forming minerals and rocks as given in theory. Study of fossils given in theory. Drawing of profile, section, description of physiography and geology of given geological map.

GEOLOGY**Semester II****Generic Elective Course****Paper GE 2-ECONOMIC AND APPLIED GEOLOGY(6 Credits)****UNIT-I: Economic Geology**

Concept of ore mineral, Gangue, Ore, Tenor. Outline of the process of formation of ore deposits. Mineral resources of Odisha.

UNIT-II: Hydrogeology

Hydrologic cycle, Hydrological properties of rock as porosity, Permeability, Vertical Zonation of ground water, Aquifer, Aquiclude, Aquitard, Aquiclude and Aquifer, type of Aquifer, Ground water.

UNIT-III: Engineering Geology

Geology of Reservoirs and Dams, Soil erosion and Conservation.

UNIT-IV: Mineral Prospecting

Geological, Geophysical and Geochemical methods for mineral prospecting.
Impact of mining activity on Environment.

PRACTICAL: (Credit 2)

Identification of ore mineral, Problems related to ground water: Calculation of Coefficient permeability and Seepage Velocity of ground water. Study and interpretation of geological map for selection of dam site

Field study: Visit to local geological exposure for study of lithology, structure and Geomorphological features (4 days) followed by a report.

SUGGESTED READING:

1. Text Book of Geology- P.K Mukherjee
2. Text Book Of Geology-G.B Mohapatro,C.B.S Publishers
3. Text Book of Physical geology- G.B Mohapatro
4. Principles of engineering geology-K.M Bangar, Standard Publishers
5. A hand book of Economic Geology- A.K SEN and P.K GUHA
6. Bureous Higher Secondary Geology (Part-1) (2009) The odisha state Bureau of text book preparation and production, Pustak bhawan, BBSR
7. Bureaus Higher Secondary Geology (Part-2) (2011) The odisha state Bureau of Textbook Preparation and production, pustak bhawan, BBSR
8. A Dasgupta (2006) An introduction of earth science, World Press, Kolkata.
9. A Holmes – Principles of physical geology