



**SYLLABUS OF B.SC. (HONOURS) IN
EARTH SCIENCES**

**JIS UNIVERSITY,
81, Nilgunj Road, Agarpara
Kolkata -700109**

B.Sc. (HONOURS) EARTH SCIENCES SYLLABUS**FIRST SEMESTER**

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDIT	CONTACT HOURS
Core -I	BGL 101	Earth System Science	3	1	0	4	4
Core -II	BGL 102	Mineral Science	3	1	0	4	4
GE-1	BMTH 101	Mathematics I	3	1	0	4	4
GE-2	BCH 101 /BPH 101	Chemistry I/Physics I	3	1	0	4	4
AECC	BHU 101	English	2	0	0	2	2
Core -I Practical	BGL 191	Earth System Science Practical	0	0	3	2	3
Core -II Practical	BGL 192	Mineral Science Practical	0	0	3	2	3
GE-2 Practical	BCH 191 /BPH 191	Chemistry I/Physics I Practical	0	0	3	2	3
	BGL 181	Seminar				1	2
	TOTAL		14	4	9	25	29

B.Sc.(HONOURS) EARTH SCIENCES SYLLABUS**SECOND SEMESTER**

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDIT	CONTACT HOURS
Core Course-IV	BGL 201	Structural Geology and Tectonics	4	0	0	4	4
Core Course-IV	BGL 202	Geochemistry	3	0	0	3	3
GE-3	BMTH 201	Mathematics II	3	1	0	4	4
GE-4	BCH 201 /BPH 201	Chemistry II/Physics II	3	1	0	4	4
AECC		Environmental Science	2	0	0	2	2
Core Course-IV L	BGL 291	Structural Geology and Tectonics Lab	0	0	3	2	3
	BGL 292	Geochemistry Lab	0	0	3	2	3
GE-4 L	BCH 291 /BPH 291	Chemistry II/Physics II Lab	0	0	3	2	3
		Seminar				1	2
		Skill Development				1	2
	BGL 293	Field Work I	0	0	0	4	
		TOTAL	15	3	9	30	30

B.Sc. (HONOURS) EARTH SCIENCES SYLLABUS**THIRD SEMESTER**

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDIT	CONTACT HOURS
	BGL 301	Igneous Petrology	3	1	0	4	4
	BGL 302	Metamorphic Petrology	3	1	0	4	4
	BGL 303	Geology of India	3	1	0	4	4
	BMTH 301	Mathematics III	3	1	0	4	4
		Environmental Science	2	0	0	2	2
	BGL 391	Igneous Petrology Lab	0	0	3	2	3
	BGL 392	Metamorphic Petrology Lab	0	0	3	2	3
	BGL 393	Structural Geology Lab	0	0	3	2	3
	BDS 381	Seminar				1	2
		TOTAL	14	4	9	25	29

B.Sc. (HONOURS) EARTH SCIENCES SYLLABUS

FOURTH SEMESTER (OLD)

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDIT	CONTACT HOURS
	BGL 401	Economic Geology	4	0	0	4	4
	BGL 402	Engineering Geology	3	1	0	4	4
	BGL 403	GIS and Remote Sensing	4	0	0	4	4
	BGL 491	Economic Geology Practical	0	0	3	2	3
	BGL 492	GIS and Remote Sensing Practical	0	0	3	2	3
	BGL 493	Field Training				4	1 week
	BDS 481	Seminar	0	0	1	1	1
		TOTAL	11	1	7	21	19+

B.Sc. (HONOURS) EARTH SCIENCES SYLLABUS**FIFTH SEMESTER (OLD)**

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDITS	CONTACT HOURS
	BGL 501	Exploration Geology	4	0	0	4	4
	BGL 502	Hydrogeology	3	1	0	4	4
	BGL 503	Geophysics	3	1	0	4	4
	BGL 504	Evolution of Life through time	3	1	0	4	4
	BGL 591	Exploration Geology Field				2	
		Environmental Science	0	0	3	2	3
	BMTH 501	Maths	0	0	3	2	3
		Seminar				1	2
		Exploration Geology Field	0	0	0	2	
	TOTAL		9	3	9	25	23

B.Sc. (HONOURS) EARTH SCIENCES SYLLABUS**SIXTH SEMESTER (OLD)**

	SUBJECT CODE	SUBJECT NAME	L	T	P	CREDIT	CONTACT HOURS
	BGL 601	Geochemistry	3	1	0	4	4
	BGL 602	Fossil Fuel	3	1	0	4	4
	BGL 603	Quarternary Geology and Palaeoclimate	3	1	0	4	4
	BGL 604	Project Work				4	4
	MPED	Management Practices	1	1	0	2	2
		Skill-X				1	1
		Project & Seminar				1	1
	TOTAL		10	4	0	20	20

MPED: MANAGEMENT PRACTICES & ENTREPRENEURSHIP DEVELOPMENT

Syllabus Details

CORE – 1 Earth System Science

Theory

Unit 1: Earth as a Planet

Branches of Earth Sciences.

General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and jovian planets.

Meteorites and Asteroids.

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

Origin of atmosphere, ocean and life.

Unit 2: Solid Earth, Hydrosphere, Atmosphere and Biosphere

Mechanical layering of the Earth: lithosphere, asthenosphere, mantle and core.

Earthquake and earthquake belts: seismic waves and internal constitution of the Earth.

Volcanoes and volcanism, distribution of volcanoes.

Concept of isostasy.

Formation of core, mantle, crust, atmosphere, hydrosphere and biosphere.

Convection in Earth's core and production of its magnetic field.

Geothermal gradient and internal heat of the Earth.

Unit 3: Cosmic abundance of elements

Distribution of elements in solar system and in Earth.

Composition of the Earth. General concepts about geochemical cycles.

Properties of common elements in Earth.

Concepts of geochemical cycles.

Unit 4: Hydrosphere and Atmosphere

Oceanic current system and effect of Coriolis force.

Concepts of eustasy.

Land-sea interaction: Wave erosion and beach processes.

Atmospheric circulation.

Weather and climatic changes.

Unit 5: Plate Tectonics

Historical development of the concept of continental drift and plate tectonics.

Plates and plate boundaries.

Geodynamic elements of Earth: mid oceanic ridges, trenches, transform faults and island arcs.

Plate tectonics: mountain belts and rift valleys.

Unit 6: Soil

Soils: types, soil profile, processes of formation of soil.

Unit 7: Understanding the past from Stratigraphic records

Nature of stratigraphic records.

Fundamental laws of stratigraphy: laws of superposition and faunal succession.

Absolute and relative time in Geology. Concept of time and geological time scale

Concept of radiometric dating. Radiometric dating of rocks and minerals: U-Pb, Pb-Pb, K-Ar, Rb-Sr, Sm-Nd methods. Dating igneous and sedimentary rocks.

Concepts of neptunism, plutonism, uniformitarianism, and catastrophism.

Geological time scale.

Practicals

Study of major geomorphic features and their relationships with outcrops through maps and physiographic models.

Detailed study of topographic sheets and preparation of physiographic description of an area.

Study of soil profile of a specific area.

Distribution of major lithostratigraphic units of India.

Global distribution of cratons, mobile belts and major sedimentary basins. Distribution of cratons, mobile belts and major sedimentary basins in India

Calculation of Richter magnitude from P and S wave interval data.

Suggested Readings

- ▶ Duff, P. M. D. and Duff, D. (Eds.) (1993). Holmes' principles of physical geology. Taylor and Francis.
- ▶ Emiliani, C. (1992). Planet Earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
- ▶ Gross, M. G. (1977). Oceanography: A view of the earth.
- ▶ Tarback, E. J. and Lutgens, F.K. (2006). Earth Science. Pearson Prentice Hall, New Jersey.
- ▶ Grotzinger, J., Jordan, T.H., Press, F and Siever, R. (2007) Understanding Earth (Fifth Edition). W. H. Freeman and company, New York.

CORE – 2 Mineral Science

Theory

Unit 1: Crystallography

Concept of crystal and crystalline matter. Internal order in crystal.

Crystal structure; elementary ideas about crystal morphology in relation to internal structures.

Crystal parameters and indices; form and zone.

Stereographic projection of crystal faces. Crystal symmetry, classification of crystals into systems and point groups. International symbol of point groups.

Unit 2: Atomic arrangements and Mineral structure

Atomic arrangements: unit cell, CCP, FCC and HCP.

Ionic radius and coordination, Pauling's rules. Solid Solution, polymorphism, pseudomorphism.

Atomic structure of silicate minerals.

Unit 3: Rock forming minerals

Minerals - definition and classification, physical and chemical properties.

Chemical classification of minerals.

Composition of common oxides, carbonates, sulphides and sulphates, phosphates.

Composition of common rock-forming minerals.

Unit 4: Crystal Optics

Nature of light and optical behaviour of crystals.

Introduction to petrological microscope.

Practicals

Study of the symmetry of crystals. Stereographic projection of crystals.

Derivation of structural formulae based on composition.

Study of physical properties of minerals in hand specimen - Silicates: olivine, garnet, andalusite, sillimanite, kyanite, staurolite, beryl, tourmaline, pyroxene, tremolite, hornblende-actinolite, serpentine, talc, muscovite, biotite, quartz, feldspar, nepheline, zeolite, asbestos.

Quartz varieties: chert, chalcedony, agate, jasper, amethyst, rock crystal.

Other minerals: pyrite, chalcopyrite, galena, sphalerite, barite and gypsum, magnetite, haematite, pyrolusite and psilomelane, corundum, ilmenite, chromite, bauxite; fluorite, calcite, dolomite, apatite, graphite.

Study of optical properties of common rock-forming minerals: quartz, orthoclase, microcline, plagioclase, perthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, staurolite, garnet, muscovite, biotite, calcite.

Suggested Readings

- ▶ Klein, C., Dutrow, B., Dwight, J., and Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley and Sons.
- ▶ Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
- ▶ Deer, W. A., Howie, R. A., and Zussman, J. (1996). An Introduction to Rock-Forming Minerals. Prentice Hall.
- ▶ Nesse, W. D. (2011). Introduction to Optical Mineralogy (Fourth Edition). Oxford University Press.

► Putnis, A. (1992). Introduction to Mineral Sciences. Cambridge University

BGL 301 Igneous Petrology

Theory

Unit 1: Introduction to Igneous Petrology

Modes of magma formation in the crust and upper mantle. Physical properties of magma - temperature, viscosity, density and volatile content. Modes of emplacement of igneous rocks: volcanic, hypabyssal, plutonic.

Unit 2: Forms of Igneous rock bodies

Mode of occurrence of Igneous rocks.

Forms of igneous rocks.

Unit 3: Texture and Microstructure of Igneous rocks

Crystallinity, granularity, shapes and mutual relations of grains; nucleation and growth of igneous minerals.

Description of the following textures and microstructures with their occurrence in different rocks - panidiomorphic, hypidiomorphic, allotriomorphic, porphyritic, vitrophyric, poikilitic, ophitic, subophitic, intergranular, intersertal, pilotaxitic, trachytic, graphic, granophyric, rapakivi, orbicular, corona, perthitic, myrmekitic, variolitic, spherulitic and spinifex.

Binary and ternary phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic magmas.

Magma generation in crust and mantle, their emplacement and evolution.

Unit 4: Classification of Igneous rocks

Bases of classification of igneous rocks: mineralogical, textural, chemical, chemico-mineralogical and associational. Norm and mode. Standard classification schemes – Niggli, Hatch and Wells and IUGS. TAS diagram for volcanic rocks.

Composition and texture of important igneous rocks: granitoids, pegmatite, syenite, monzonite, diorite, norite, gabbro, anthrothosite, dolerite, pyroxenites, peridotite, lamprophyres, carbonatite, rhyolite, andesite, dacite, basalt, komatiite.

Unit 5: Phase Diagrams

Phase rule and its application to eutectic, peritectic and solid solution system. Phase equilibria in the following binary and ternary systems, and their petrogenetic significance: diopside – anorthite, forsterite – silica, albite – anorthite, albite – orthoclase, diopside – albite – anorthite, forsterite – diopside – silica and nepheline - kalsilite – silica.

Unit 6: Petrogenesis of Igneous rocks

Magma generation in crust and mantle, their emplacement and evolution.

Petrogenesis of felsic and mafic igneous rocks: granitoids, basalt, gabbros, anorthosite, komatiites, alkaline rocks, kimberlites.

Unit 7: Magmatism in different tectonic settings

Magmatism in the oceanic domains (MORB, OIB).

Magmatism along the subduction zones: Island arcs and continental arcs.

Magmatism along continental rifts.

BGL 391 Igneous Petrology Practicals

Study of important igneous rocks in hand specimens and thin sections: granite, granodiorite, diorite, syenite, nepheline syenite, gabbro, anorthosite, ultramafic rock, basalt, andesite, trachyte, rhyolite, dacite.

Norm calculation. Visual estimation of modes from thin sections.

Plotting of mode in IUGS classification of plutonic rocks (Streckeisen diagram).

Reference Books

- ▶ Philpotts, A. and Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
- ▶ Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
- ▶ Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
- ▶ Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.

- ▶ Myron G. Best (2001). Igneous and Metamorphic Petrology.
- ▶ Cox, K. G. and Bell. J. D. (1979). The Interpretation of Igneous Rocks. Springer/Chapman and Hall.
- ▶ Bose M. K. (1997). Igneous Petrology.
- ▶ Frost B. R. and Frost C. D (2014). Essentials of Igneous and Metamorphic Petrology. Cambridge University Press

BGL 302 Metamorphic Petrology

Theory

Unit 1: Metamorphism: Controls and Types

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

Causes of metamorphism and concept of metamorphic P-T-t paths.

Unit 2: Metamorphic Facies and Grades. Metamorphic Structures and Textures

Index minerals, metamorphic zones and isograds. Structure and textures of metamorphic rocks.

Concept of metamorphic facies and grade.

Mineralogical phase rule of closed and open system.

Composition-paragenesis diagrams. ACF, AKF and AFM diagrams.

Metamorphic products of pelitic, carbonate and mafic igneous rocks.

Unit 3: Metamorphic reactions. Metamorphism and deformation.

Progressive and retrogressive metamorphism.

Prograde and retrograde metamorphic minerals reactions.

Relationship between metamorphism and deformation.

Unit 4: Migmatites and their origin

Metasomatism and role of fluids in metamorphism.

Brief idea of crustal anatexis. Migmatites and its origin.

Unit 5: Metamorphic rock associations and Plate Tectonic settings

Regional occurrence and tectonic significance of metamorphic rocks: metamorphism along convergent plate margins, in continent-continent collisions, in rifting terrains and sea floor metamorphism.

BGL 392 Metamorphic Petrology Practicals

Hand specimen study of following metamorphic rocks: slate, phyllite, schist, gneiss, amphibolite, charnockite, khondalite, mafic granulite, marble.

Textural and mineralogical study of following metamorphic rocks in thin sections: slate, varieties of schists, gneiss, amphibolite, charnockite, khondalite, mafic granulite, eclogite, marble, high Mg-Al granulites.

Graphical plots of metamorphic mineral assemblages using chemographic diagrams.

Reference Books

- ▶ Philpotts, A. and Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
- ▶ Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
- ▶ Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
- ▶ Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
- ▶ Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Scientific and Technical, London.
- ▶ Spear F. S. (1993). Metamorphic phase equilibria and Pressure-Temperature-Time paths. Mineralogical Society of America.

BGL 303 Geology of India

Theory

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: Code of stratigraphic nomenclature

International Stratigraphic Code – development of a standardized stratigraphic nomenclature.

Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).

Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy,

Magnetostratigraphy

Sequence stratigraphy and their subdivisions with Indian examples.

Unit 3: Principles of stratigraphic analysis Facies concept in stratigraphy

Walther's Law of Facies.

Concept of paleogeographic reconstruction

Unit 4: 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 Cudappah basins of India

Unit 5: Phanerozoic Stratigraphy of India

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 successions of Spiti,

- b. Jurassic of Kutch,
- c. Cretaceous, successions of Cauvery basins

Cenozoic stratigraphy of India:

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

Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and

Saurashtra basins and their potential for hydrocarbon exploration

Unit 6: Volcanic provinces of India

- a. Deccan,
- b. Rajmahal,
- c. Sylhet Trap

Unit 7: Stratigraphic boundaries

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

BGL –393 Structural Geology Practicals

Basic idea of topographic maps. Topographic sheets of various scales. Interpretation of topographic maps.

Interpretation of geological maps with unconformity, fault, fold and igneous bodies. Construction of structural cross section.

Stereographic projections of planes and lines.

True dip and apparent dip problems, 3-point problems, fold problems, fault problems and their solutions through stereographic projection methods.

Reference Books

- ▶ Davis, G. R. (1984). Structural Geology of Rocks and Region. John Wiley
- ▶ Billings, M. P. (1987). Structural Geology, 4th edition. Prentice-Hall.
- ▶ Ragan, D. M. (2009). Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
- ▶ Twiss, R. J. and Moores, E. M. (2007) Structural Geology. Second Edition. W. H. Freeman and Company.
- ▶ Fossen, H. (2010). Structural Geology. Cambridge University Press.
- ▶ Marshak, S. and Mitra, G. (1988). Basic Methods in Structural Geology. Prentice

BGL 401 Economic Geology

Theory

Unit 1: Ores and Gangues

Ores, gangue minerals, tenor, grade and lodes.

Resources and reserves- economic and academic definitions.

Unit 2: Mineral deposits and Classical concepts of Ore formation

Mineral occurrence, mineral deposit and ore deposit.

Historical concepts of ore genesis: Man's earliest vocation- mining.

Plutonist and Neptunist concepts of ore genesis.

Metallogenic provinces and epochs.

Unit 3: Mineral exploration

Exploration and exploitation techniques.

Brief idea on: remote sensing, geophysical and geochemical explorations.

Geological mapping of ore bodies at different scales, drilling, borehole logs and transverse sections.

Unit 4: Structure and texture of ore deposits

Concordant and discordant ore bodies.

Endogenous processes: magmatic concentration, skarns, greisens, and hydrothermal deposits.

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

Unit 5: Ore grade and Reserve

Assessment of ore grade and reserve, reserve estimation.

Unit 6: Metallic and Nonmetallic ores

Important deposits of India including atomic minerals: study of geologic set up, mode of occurrence, mineralogy and genesis of the following ore deposits in India: iron ore in Singhbhum and Karnataka, Manganese of Central India, copper of Malanjkhand, lead-zinc of Zawar area, uranium of Singhbhum.

Non-metallic and industrial rocks and minerals in India.

Introduction to gemstones.

BGL 491 Economic Geology Practicals

Hand sample identification of important ores and nonmetallic minerals.

Study of microscopic properties of ore forming minerals (oxides and sulphides).

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

Reference Books

- ▶ Guilbert, J.M. and Park Jr. C.F. (1986). The Geology of Ore deposits. Freeman and Co.
- ▶ Bateman, A.M. and Jensen, M.L. (1990). Economic Mineral Deposits. John Wiley.
- ▶ Evans, A.M. (1993). Ore Geology and Industrial minerals. An Introduction. (Third Edition). Blackwell Publishing.
- ▶ Robb, L. J. (2005). Introduction to ore forming processes. Wiley.
- ▶ Deb, S. (1980). Industrial minerals and rocks of India. Allied Publishers.
- ▶ Sarkar, S.C. and Gupta, A. (2014). Crustal Evolution and Metallogeny in India. Cambridge Publications.
- ▶ Mookherjee A. (1999). Ore Genesis A Holistic approach. Allied Publishers Pvt. Ltd.

► Stanton, R. L. (1972). Ore Petrology. McGraw-Hill Book company.

BGL 402 Engineering Geology

Theory

Unit 1: Introduction

Role of Engineering geologists in planning, design and construction of major man-made structural features.

Unit 2: Site investigation

Site investigation and characterization.

Unit 3: Foundation

Foundation treatment; Grouting, Rock Bolting and other support mechanisms.

Unit 4: Intact Rock and Rock Mass properties

Rock aggregates; significance as construction material.

Unit 5: Rock Quality Designation (RQD)

Concept, mechanism and significance of:

Rock Structure Rating (RSR)

Rock Mass Rating (RMR)

Tunneling Quality Index (Q)

Geological, Geotechnical and Environmental considerations for dams and reservoirs.

Unit 6: Tunnels

Tunneling methods.

Unit 7: Landslides

Causes, factors and corrective/preventive measures.

Unit 8: Earthquakes

Corrective/preventive measures. Mitigating the damage caused by earthquake.

Unit 9: Civil Engineering Projects

Case histories related to Indian Civil Engineering Projects.

Reference Books

- ▶ Krynin, D.P. and Judd W.R. (1957). Principles of Engineering Geology and Geotechnique. McGraw Hill (CBS Publ).
- ▶ Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.
- ▶ Goodman, R.E. (1993). Engineering Geology: Rock in Engineering constructions. John Wiley and Sons, New York.
- ▶ Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.). Taylor and Francis.
- ▶ Bell: F.G. (2006). Basic Environmental and Engineering Geology. Whittles Publishing.
- ▶ Bell, .F.G (2007). Engineering Geology. Butterworth-Heineman.

BGL 403 GIS and Remote Sensing

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 2: Remote Sensing, Concepts in Remote Sensing

Sensors and scanners

Satellites and their characteristics

Data formats- Raster and Vector

Unit 3: 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 4: GIS, Datum,

Coordinate systems and Projection systems

Spatial data models and data editing

Introduction to DEM analysis

Unit 5: GPS,

Concepts of GPS

Integrating GPS data with GIS

Applications in earth system sciences

BGL 493 GIS and Remote Sensing Practicals

Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various
aeolian, glacial, fluvial and marine landforms

Introduction to DIP and GIS softwares. Digital Image Processing exercises including analysis of
satellite

data in different bands and interpretation of various objects on the basis of their spectral

signatures
Creating a FCC from raw data, Registration of satellite data with a toposheet of the area

Enhancing the satellite images; Generating NDVI images and other image ratio and its interpretation

Classification of images. DEM analysis: generating slope map, aspect map and drainage network map
and its applications

Reference Books

1. Demers, M.N., 1997. *Fundamentals of Geographic Information System*, John Wiley & sons. Inc.

2. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. *GPS: Theory & Practice*, Springer Wien New York.
3. Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer- Verlag.
4. Lillesand, T. M. & Kiefer, R.W., 2007. *Remote Sensing and Image Interpretation*, Wiley.
5. Richards, J.A. and Jia, X., 1999. *Remote Sensing Digital Image Analysis*, Springer-Verlag.

BGL 501 Exploration Geology

Theory

Unit: 1 Mineral Resources

Resource: definition. Mineral resources in industries – historical perspective, present scenario, classification of mineral deposits with respect to processes of formation; Exploration strategies.

Unit: 2 Prospecting and Exploration

Principles of mineral exploration

Prospecting and exploration: conceptualization, methodology and stages, sampling, subsurface sampling including pitting, trenching and drilling

Geochemical exploration.

Outline of exploration techniques for ferrous and non-ferrous metals, limestone, coal and petroleum

Unit: 3 Evaluation of data

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

Unit: 4 Drilling and Logging

Core and non-core drilling

Planning of bore holes and location of boreholes on ground core-logging

Unit: 5 Reserve estimations and Errors

Principles of reserve estimation, factors affecting reliability of reserve estimation; reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks)

Regular and irregular grid patterns

Statistics and error estimation

Reference Books

- ▶ Clark, G.B. (1967). Elements of Mining. 3rd Ed. John Wiley and Sons.
- ▶ Arogyaswami, R.P.N. (1996). Courses in Mining Geology. 4th Ed. Oxford-IBH.
- ▶ Moon, C.J., Whateley, M.K.G. and Evans, A.M. (2006). Introduction to Mineral Exploration, Blackwell Publishing.
- ▶ Haldar, S.K., 2013. Mineral Exploration – Principles and Applications. Elsevier Publication.

Field

Industrial or mine visit and preparation of report

BGL 502 Hydrogeology

Theory

Unit 1: Introduction and basic concepts

Scope of hydrogeology and its societal relevance. Global and Indian distribution of water resource.

Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and groundwater flow. Basic concept of hydrographs. Origin of groundwater, vertical distribution of subsurface water. Genetic classification of groundwater. Classification of rocks with respect to water bearing characteristics. Geomorphic and geologic controls of groundwater. Types of aquifer– unconfined, confined and semi-confined. Water table and piezometric surface. Groundwater provinces in India and West Bengal.

Rock properties affecting groundwater- porosity, void ratio, specific retention and storage coefficient; specific yield, specific storage and storativity; anisotropy and heterogeneity of aquifers.

Unit 2: Groundwater flow

Darcy's law and its validity; Reynold's Number. Groundwater velocity.

Intrinsic permeability and hydraulic conductivity, transmissivity, measurement of hydraulic conductivity in laboratory – Constant Head Permeameter and Falling (Variable) Head Permeameter. Water table and piezometric surface contour maps and groundwater flow direction; laminar and turbulent groundwater flow.

Unit 3: Well hydraulics and Groundwater exploration

Basic Concepts (drawdown, specific capacity etc).

Elementary concepts related to equilibrium and non-equilibrium (steady and unsteady) conditions for groundwater flow to a well.

Surface-based groundwater exploration methods. Introduction to subsurface borehole logging methods.

Unit 4: Groundwater chemistry

Physical, chemical and bacteriological properties of water and water quality.

Introduction to methods of interpreting groundwater quality data using standard graphical plots.

Elementary concept on groundwater pollution: arsenic, fluoride and nitrate, sea water intrusion in coastal aquifers; Ghyben-Herzberg relation.

Unit 5: Groundwater management

Surface and subsurface water interaction. Recharge and discharge areas. Groundwater level fluctuations. Effects of climate change on groundwater.

Basic concepts of water balance studies, issues related to groundwater resources development and management.

Rainwater harvesting and artificial recharge of groundwater.

Reference Books

- ▶ Todd, D. K. and Larry, W.M.(2005). Groundwater Hydrology, 3rd Ed. John Wiley and Sons, N.Y.
- ▶ Davis, S. N. and De Weist, R. J. M. (1966). Hydrogeology. John Wiley and Sons Inc., New York.
- ▶ Karanth K.R. (1987). Groundwater: Assessment, Development and management. Tata McGraw-Hill Pub. Co. Ltd.
- ▶ Raghunath H, M. (2007). Groundwater. 3rd Ed. New Age International Publishers, New Delhi.

BGL 503 Introduction to Geophysics

Geology and Geophysics

What is geophysics?

Interrelationship between geology and geophysics.

Geophysical methods

Different types of geophysical methods - gravity, magnetic, electrical and seismic; principles of different methods. Applications of different methods. Elements of well logging.

Corrections in geophysical data.

Geophysical field operations

Data acquisition and processing. Data reduction. Signal and noise.

Different types of surveys, grid and route surveys, profiling and sounding techniques;

Scales of survey

Presentation of geophysical data

Application of Geophysical methods

Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.

Geological interpretation of geophysical data.

Geophysical anomalies

Correction to measured quantities, geophysical anomaly, regional and residual (local) anomalies, factors controlling anomaly

Depth of exploration

Integrated geophysical methods

Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

Reference Books

- ▶ Ramachandra Rao, M.B. Prasaranga (1975), Outlines of Geophysical Prospecting - A manual for geologists, University of Mysore, Mysore, 1975.
- ▶ Bhimasarikaram V.L.S. (1990), - An Outline on Exploration Geophysics, Association of Exploration Geophysicists, Osmania University, Hyderabad.
- ▶ Dobrin, M.B. (1984), An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
- ▶ Telford, W. M., Geldart, L. P., and Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge university press.
- ▶ Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.
- ▶ Mussett, A. E. and Khan, M. A. (2000). Looking into the Earth. Cambridge University Press.

BGL 504 Evolution of Life through Time

Theory

Life through ages

Fossils and chemical remains of ancient life.

Geological Time Scale with emphasis on major bio-events.

Biom mineralization and skeletalization.

Principle

Mechanism of evolution

Evolutionary lineages

Species as basic unit of linea

Costraints in lineage reconstruction

Geobiology

Biosphere as a system, processes and products.

Biogeochemical cycles.

Abundance and diversity of microbes, extremophiles.

Microbes-mineral interactions, microbial mats

Origin of life

Possible life sustaining sites in the solar system, life sustaining elements and isotope records.

Archean life: Earth's oldest life, transition from Archean to Proterozoic; the oxygen revolution and radiation of life.

Precambrian macrofossils – The garden of Ediacara. The Snow Ball Earth hypothesis.

Paleozoic Life

The Cambrian explosion.

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; spread of flowering plants.

Cenozoic Life

Aftermath of end Cretaceous mass extinction – radiation of placental mammals evolution of modern grasslands and co-evolution of hoofed grazers

Rise of modern plants and vegetation. Back to water – evolution of whales

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.

Effects of life on climate and geology.

Applications Of Evolution

Biostratigraphy and chronostratigraphy in the context of organic evolution.

Role of fossils in correlation.

Basis of stage boundaries in the Phanerozoic.

Reference Books

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

BGL 601 Elements of Geochemistry

Theory

Unit 1: Basic Concepts

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 the bulk silicate Earth.

Composition of core.

Composition of mantle: depleted mantle and enriched mantle.

Composition of crust: Continental and Oceanic.

Isotope geology: Isotopic and elemental fractionation.

Radiogenic and stable isotopes in Earth materials.

Unit 3: Element transport

Advection and diffusion.

Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations.

Elements of marine chemistry.

Mineral reactions- diagenesis and hydrothermal reactions.

Unit 4: Geochemistry of solid Earth

Geochemical variability of magma and its products. Melting processes.

Unit 5: Geochemical behaviour of selected Elements

Si, Al, K, Na, Ca, Fe, Mg, Ti.

Elements of Geochemistry

Reference Books

- ▶ Mason, B. (1986). Principles of Geochemistry. 3rd Edition, Wiley, New York.
- ▶ Rollinson, H. (2007). Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific and Technical.
- ▶ Walther, J. V. (2009). Essentials of geochemistry. Jones and Bartlett Publishers.
- ▶ Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
- ▶ Faure, Gunter and Teresa M. Mensing (2004). Isotopes Principles and Applications. Wiley India Pvt. Ltd

BGL 602 Fuel Geology

Theory

Unit 1: Energy resources

Different sources of energy: Global and Indian scenario.

Unit 2: Coal

Definition and origin of Coal.

Basic classification of coal.

Fundamentals of coal petrology - introduction to lithotypes, microlithotypes and macerals in coal.

Proximate and ultimate analysis of coal.

Major coal basins of India.

Coal as a fuel

Concept of clean coal technology

Coal Bed Methane (CBM): global and Indian scenario

Underground coal gasification

Liquefaction of coal

Unit 3: Petroleum

Chemical composition and physical properties of crudes oil

Origin of and migration of petroleum

Kerogen: maturation of kerogen; biogenic and thermal effect

Unit 4: Petroleum Reservoirs and Traps

Reservoir rocks: general attributes and petrophysical properties

Cap rocks: definition, general properties

Hydrocarbon traps: definition, classification of hydrocarbon traps - structural, stratigraphic and combination trap.

Time of trap formation and time of hydrocarbon accumulation.

Plate tectonics and global distribution of hydrocarbon reserves

Petroliferous basins of India

Other fuels

Nuclear Fuel

Gas Hydrate

Reference Books

► Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

► Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press

- ▶ Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
- ▶ Bastia, R., and Radhakrishna, M. (2012). Basin evolution and petroleum prospectively of the continental margins of India (Vol. 59). Newness.

BGL 603 Quaternary Geology and Palaeoclimate

Quaternary Geology

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.

Quaternary stratigraphy of India. Continental records (fluvial, glacial, Aeolian, Paleosols and duricrust); marine records; continental marine correlation of Quaternary record.

Evolution of Man and Stone Age culture. Plant and animal life in relation to glacial and interglacial cycles during Quaternary.

Paleoclimatology

Introduction to climate and climate systems, Global climate pattern, Climate controlling factors. Global energy budget, Plate tectonics and climate change Milankovitch cycles, Atmosphere and Ocean interaction and its effect on climate.

An Overview of Paleoclimatic reconstruction; Pleistocene Glacial-Interglacial cycles; Future Climate: Anthropogenic activity and its effect on Global climate.

Reference Books:

1. Bigg, G., 1999 Ocean and Climate. Springer- Verlag
2. Bradley, F., 2000. Paleoclimatology: Reconstructing Climates of the Quaternary. Springer- Verlag.
3. Maher and Thompson, 2000. Quaternary Climates, Environments and Magnetism. Cambridge University Press.
4. Williams, Durnkerley, Decker, Kershaw and Chhappell, 1998. Quaternary Environments. Wiley and Sons