

**MINIMUM COURSE CURRICULUM FOR B.Sc. (HONOURS)
GEOLOGY UNDER CHOICE BASED CREDIT SYSTEM**



**DEPARTMENT OF GEOLOGY
JAGANNATH BAROOAH COLLEGE (AUTONOMOUS)
JORHAT (ASSAM)**

(Approved by Academic Council on June, 2019)

Course Structure-GEOLOGY (Honours)

Core										
Semester	Course No	Course Code	Course Title	Course Type	Marks Distribution					Remarks
					TH	TH-IA	PR	PR-IA	Total	
1 st	C-01	GEOC-101	Earth System Science	Theory + Practical	50	15	30	05	100	
	C-02	GEOC-102	Mineral Science	Theory + Practical	50	15	30	05	100	
2 nd	C-03	GEOC-201	Elements of Geochemistry	Theory + Practical	50	15	30	05	100	
	C-04	GEOC-202	Structural Geology	Theory + Practical	50	15	30	05	100	
3 rd	C-05	GEOC-301	Igneous Petrology	Theory + Practical	50	15	30	05	100	
	C-06	GEOC-302	Sedimentary Petrology	Theory + Practical	50	15	30	05	100	
	C-07	GEOC-303	Paleontology	Theory + Practical	50	15	30	05	100	
	SEC-01	GEOS-301	Basic Field Training	Practical	--	--	40*	10	50	
4 th	C-08	GEOC-401	Metamorphic Petrology	Theory + Practical	50	15	30	05	100	
	C-09	GEOC-402	Stratigraphic Principles and Indian Stratigraphy	Theory + Practical	50	15	30	05	100	
	C-10	GEOC-403	Hydrogeology and Oceanography	Theory + Practical	50	15	30	05	100	
	SEC-02		Field Work	Practical	--	--	40*	10	50	
5 th	C-11	GEOC-501	Economic Geology	Theory + Practical	50	15	30	05	100	
	C-12	GEOC-502	Geomorphology	Theory + Practical	50	15	30	05	100	
	DSE 1	GEOD-501	Exploration Geology	Theory + Practical	50	15	30	05	100	
	DSE 2	GEOD-502	Earth and Climate	Theory + Practical	50	15	30	05	100	
6 th	C-13	GEOC-601	Engineering Geology	Theory + Practical	50	15	30	05	100	
	C-14	GEOC-602	Remote Sensing and GIS	Theory + Practical	50	15	30	05	100	
	DSE 3	GEOD-601	Fuel Geology	Theory + Practical	50	15	30	05	100	
	DSE 4	GEOD-602	River Science	Theory + Practical	50	15	30	05	100	
Generic Elective-Geology										
1 st	GE-01	GEOG-101	Essentials of Geology	Theory + Practical	50	15	30	05	100	
2 nd	GE-02	GEOG-201	Rocks and Minerals	Theory + Practical	50	15	30	05	100	
3 rd	GE-04	GEOG-301	Physics and Chemistry of Earth	Theory + Practical	50	15	30	05	100	
4 th	GE-04	GEOG-401	Earth Resource	Theory + Practical	50	15	30	05	100	

Project-40 (Report-25, Presentation and Viva-15)

Programme Objectives
SCIENCE STREAM
 Course Outcomes
B.Sc. Geology(Honours) Programme
 JagannathBarooah College

CORE CODE	Name of the Course	Course Outcomes
GEOC 101	Earth System Science	At the end of this course the student will have knowledge and understanding of <ul style="list-style-type: none"> • The planet Earth as integral part of the universe, with its genesis and gross characteristics being a reflection of cosmic process. • The dynamism affecting every aspect of the planet Earth and the interrelationship between the geodynamic processes. • The internal zonation of the Earth including the process of zonation and the physical and chemical characters of each zone. • The characteristics of the earth's magnetic field and the dynamic processes in the core of the Earth that generates this field. • The global geodynamic processes with focus on plate tectonics and the geodynamic elements.
GEOC 102	Mineral Science	At the end of this course the student will have knowledge and understanding of: <ul style="list-style-type: none"> • Morphology and internal structure of different crystal system and groups. • Physical chemical and optical properties of rock forming minerals.
GEOC 201	Elements of Geochemistry	At the end of this course the student will have knowledge and understanding of <ul style="list-style-type: none"> • Geochemical classification, periodic table, bonding, states of matter, atomic environment of elements from geochemical point of view. • Geochemical characters of different layers of the Earth. • Element transport and mineral reactions in different geochemical environment • Geochemistry of solid earth, solar materials and magmatic products. • Geochemical behaviour of major elements.
GEOC 202	Structural Geology	At the end of this course the student will have knowledge and understanding of <ul style="list-style-type: none"> • Relation of topography with geological structure • Mechanics of related to formation of geological structure. • Different elements, formation and classification of different types of geological structure.
GEOC 301	Igneous Petrology	At the end of this course the student will have knowledge and understanding of <ul style="list-style-type: none"> • Genesis, nature, composition, form, thermal and chemical properties of magma. • Classification, structure, texture and mode of occurrence of igneous rock. • Thermodynamic properties of igneous rock • Magmatism in different tectonic settings. • Petrogenesis of major igneous rock types.
GEOC 302	Sedimentary Petrology	At the end of this course the student will have knowledge and understanding of <ul style="list-style-type: none"> • The processes of formation of sediment and sedimentary rocks. • Structure and textures of sedimentary rock and their application in study of geological history.

		<ul style="list-style-type: none"> • Characteristics of different sedimentary rock
GEOC 303	Palaeontology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Different fossilization processes, and evolutionary theories and taxonomy of organisms. • Morphology, biostratigraphic significance and functional adaptation of some major invertebrate, vertebrate and plant fossil forms. • Academic, environmental and industrial applications fossils.
GEOC 401	Metamorphic Petrology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Agents and types of metamorphism • Metamorphic facies, grades zones, texture and structure and thermodynamics of metamorphism. • Relationship between metamorphism, tectonic and deformation and types of metamorphic reaction. • Different metamorphic rock associations, migmatites and metasomatism
GEOC 402	Stratigraphic Principles and Indian Stratigraphy	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Stratigraphic principles, units, code of stratigraphic nomenclature, different branches laws and concepts of stratigraphy. • Precambrian, phenerozoic stratigraphy of India. • Stritigraphic boundaries and volcanic providences of India.
GEOC 403	Hydrology and Oceanography	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Introductory concepts and technical definitions of hydrogeology • Laws and principles of groundwater dynamics, well hydraulics and ground water exploration. • Concepts of ground water management • Preliminary ideas of different oceanography, its branches, origin of oceans and related aspects of ocean water.
GEOC 501	Economic Geology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Introductory concepts ore deposit including the textures and structures of such deposits • Different ore forming processes • An overview of mineral exploration techniques. • Assessment of grade and reserve estimation • Metallogenic provinces and epochs and important deposits of India
GEOC 502	Geomorphology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Concepts of Geomorphology and Geomorphological processes • Landforms of different scale and origin • Interactions among different Geomorphological processes • Preliminary knowledge on Indian Geomorphology
GEOD 501	Exploration Geology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Detail idea on mineral resources, definition, and classification of mineral exploration. • Principle and methods of mineral exploration. • Evaluation of exploratory data

		<ul style="list-style-type: none"> • Principles and methods of Drilling and logging • Principles and methods estimation and error calculation
GEOD 502	Earth and Climate	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Climate system and its component • Heat budget • Different spheres of the earth and its control on climate • Local, Global and cosmic Climate controlling factors and anthropogenic factors Monsoonal activities
GEOC 601	Engineering Geology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Scope of Engineering Geology • Foundation treatment and support mechanism • Engineering properties of rock and its improvement technique • Classification of rock on the basis of engineering properties. • Geological consideration for different consruction projects • Different factors that can unsterilized mega construction.
GEOC 602	Remote Sensing	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Photogeology, aerial photographs and remote sensing • Platforms, sensors and data acquisition in remote sensing • Preliminary ideas on digital image processing • Preliminary knowledge on GIS and GPS
GEOD601	Fuel Geology	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Genesis of fossil fuels. • Constituents and classification of coal • Composition, occurance and properties of petroleum Alternative fuels
GEOD602	River Science	<p>At the end of this course the student will have knowledge and understanding of</p> <ul style="list-style-type: none"> • Variation of rivers in time and space • Activities of different types streams • Understanding on different elements of river system and their measurement • Elementary ideas on stream management

**Detailed Syllabus for Core Course
B.Sc. (Honours) Geology**

Semester-I**COURSE TITLE: EARTH SYSTEM SCIENCE****Course Code: GEOC-101****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****Practical Marks: 35****End Semester: 50****End Semester: 30****Course No: C- 01****No. of Classes: 96 (48+48)****In Semester: 15****In Semester: 05****THEORY :****Unit 1: Earth as a planet****Marks: 6**

Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography.

Introduction to various 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 and its age.

Unit 2: Earth's magnetic field**Marks: 6**

Earth's magnetic field

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

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

Mechanical layering of the Earth.

Unit 3: Plate Tectonics**Marks: 12**

Concept of plate tectonics, sea-floor spreading and continental drift

Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs

Origin of oceans, continents, mountains and rift valleys

Earthquake and earthquake belts

Volcanoes- types, products and their distribution.

Unit 4: Hydrosphere and Atmosphere**Marks: 6**

Oceanic current system and effect of Coriolis force

Concepts of eustasy

Land-air-sea interaction

Wave erosion and beach processes

Atmospheric circulation

Weather and climatic changes

Earth's heat budget.

Unit 5: Soil**Marks: 03**

Soils- processes of formation, soil profile and soil types.

Unit 6: Understanding the past from stratigraphic records**Marks: 8**

Nature of stratigraphic records

Standard stratigraphic time scale and introduction to the concept of time in geological studies

Introduction to geochronological methods and their application in geological studies

History of development in concepts of uniformitarianism, catastrophism and neptunism

Laws of superposition and faunal succession

Introduction to geology and geomorphology of Indian subcontinent.

Unit 7: Cosmic abundance of elements**Marks: 8**

Distribution of elements in solar system and in Earth

Chemical differentiation and composition of the Earth

General concepts about geochemical cycles and mass balance

Properties of elements

Geochemical behavior of major elements

Mass conservation of elements and isotopic fractionation.

Internal Assessment**Marks: 15****PRACTICALS:****MARKS: 30 + IA 05=35**

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

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

Study of soil profile of any specific area

Study of distribution of major lithostratigraphic units on the map of India

Study of distribution of major dams on map of India and their impact on river systems

Study of major ocean currents of the World

Study of seismic profile and its interpretation

SUGGESTED READINGS:

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

**Detailed Syllabus for Core Course
B.Sc. (Honours) Geology**

Semester-I**COURSE TITLE: MINERAL SCIENCE****Course Code: GEOC-102****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****Practical Marks: 35****End Semester: 50****End Semester: 30****Course No: C- 02****No. of Classes: 96 (48+48)****In Semester: 15****In Semester: 05****THEORY :****Unit 1: Crystallography****Marks: 13**

Elementary ideas about crystal morphology in relation to internal structures

Crystal parameters and indices

Crystal symmetry and classification of crystals into six systems and 32 point groups

Unit 2: Crystal symmetry and projections**Marks: 12**

Elements of crystal chemistry and aspects of crystal structures

Stereographic projections of symmetry elements and forms

Unit 3: Rock forming minerals**Marks: 13**

Minerals - definition and classification, physical and chemical properties

Composition of common rock-forming minerals

Silicate and non-silicate structures; CCP and HCP structures

Unit 4: Properties of light and optical microscopy**Marks:12**

Nature of light and principles of optical mineralogy

Introduction to the petrological microscope and identification of common rock-forming minerals

Internal Assessment**Marks: 15****PRACTICALS:****MARKS: 30 + IA 05=35**

Observation and documentation of symmetry of crystals and crystallographic projection.

Study of physical properties of minerals in hand specimen

Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite

Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.

Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite

Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.

Study of some key silicate minerals under optical microscope and their characteristic properties

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, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.

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Semester-II**COURSE TITLE: ELEMENTS OF GEOCHEMISTRY****Course Code: GEOC-201****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****Practical Marks: 35****End Semester: 50****End Semester: 30****Course No: C- 03****No. of Classes: 96 (48+48)****In Semester: 15****In Semester: 05****THEORY:****Unit 1: Concepts of geochemistry****Marks:7**

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**Marks: 10**

Composition of different Earth reservoirs and the nuclides and radioactivity

Conservation of mass, isotopic and elemental fractionation

Concept of radiogenic isotopes in geochronology and isotopic tracers

Unit 3: Element transport**Marks: 12**

Advection and diffusion

Chromatography

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**Marks: 12**

The Solid Earth – geochemical variability of magma and its products.

The Earth in the solar system, the formation of solar system

Composition of the bulk silicate Earth

Meteorites

Unit 5: Geochemical behavior of Si, Al, K, Na, Fe, Ca, Mg**Marks: 7****Internal Assessment****Marks: 15****PRACTICALS:****MARKS: 30+ IA 05=35**

Types of geochemical data analysis and interpretation; of common geochemical plots.

Marks:10

Geochemical analysis of geological materials.

Marks:08

Geochemical variation diagrams and its interpretations.

Marks:08

Viva + Practical Note Book

Marks: 04**SUGGESTED READINGS:**

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

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

**Detailed Syllabus for Core Course
B.Sc. (Honours) Geology**

Semester-II

COURSE TITLE: STRUCTURAL GEOLOGY

Course Code: GEOC-202

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 04

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY :

Unit 1: Structure and Topography

Marks: 6

Topographic and structural maps; Important representative factors of the map, Effect of topography on outcrop pattern of planar structural features.

Unit 2: Stress and strain in rocks

Marks: 10

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.

Unconformity and its types

Unit 3: Folds

Marks: 12

Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding

Unit 4: Foliation and lineation

Marks: 10

Description and origin of foliations: axial plane cleavage and its tectonic significance

Description and origin of lineation and relationship with the major structures

Unit 5: Fractures and faults

Marks: 10

Geometric and genetic classification of fractures and faults

Effects of faulting on the outcrops

Geologic/geomorphic criteria for recognition of faults and fault plane solutions

Internal Assessment

Marks: 15

PRACTICALS:

MARKS: 30+ IA 05=35

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 complexities Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

SUGGESTED READINGS:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed).
Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill

Detailed Syllabus for Core Course B.Sc. (Honours) Geology

Semester-III

COURSE TITLE: IGNEOUS PETROLOGY

Course Code: GEOC-301

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 05

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Introduction

Introduction to petrology: Heat flow, geothermal gradients through time, General idea about the composition constitution and nature of magmas and lavas. Generation of magmas.

Marks: 08

Unit 2: Igneous Rocks

Classification of igneous rocks, Textures and structures of igneous rocks. Mode of occurrence of Igneous rocks

Marks: 10

Unit 3: Phase diagrams and petrogenesis

Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic Magmas. Reaction principles and the crystallization of magmas. Evolution of magmas. Primary and derivative magmas. Role of volatiles in magma. Concept of conanguity and variation diagrams.

Marks: 14

Unit 4: Magmatism in different tectonic settings; Magmatism in the oceanic domains (MORB, OIB)
Magmatism along the plate margins (Island arcs/continental arcs)

Marks: 08

Unit 5: Petrogenesis of Igneous rocks, Petrogenesis of Felsic and Mafic igneous rocks, Komatiites, Granitoides, Basalt, Gabbros, Alkaline rocks, kimberlites, lamproites, Sylhet Traps and AborVolcanics.

Marks:10

PRACTICALS:

MARKS: 30+ IA 05=35

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. 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. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
6. Myron G. Best (2001). Igneous and Metamorphic Petrology,
7. K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
8. Bose M.K. (1997). Igneous Petrology.
9. G W Tyrrell. (1926). Principles of Petrology. Springer

**Detailed Syllabus for Core Course
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Semester-III

COURSE TITLE: SEDIMENTARY PETROLOGY

Course Code: GEOC-302

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 06

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Origin of sediments

Weathering and sedimentary flux: Physical and chemical weathering, soils and paleosols; Provenance and Heavy minerals.

Marks:10

Unit 2: Sediment granulometry

Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric

Marks:08

Unit 3: Sedimentary textures, structures and environment

Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition. Paleocurrent analysis- Paleocurrents for different sedimentary environments, Sedimentary structure- Primary and syn-sedimentary structures

Marks:12

Unit 4: Varieties of sedimentary rocks

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

Marks:10

Unit 5: Diagenesis

Concepts of diagenesis, Stages of diagenesis, Compaction, Cementation, lithification and authigenesis.

Marks:10

PRACTICALS:

MARKS: 30+ IA 05=35

Study of sedimentary rocks in hand specimens,

Study of sedimentary rocks in thin sections,

Study of texture in thin sections and hand specimens,

General overview on depositional conditions and provenance from the study of framework, cement and matrix of given sedimentary rock in thin section.

SUGGESTED READINGS:

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

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B.Sc. (Honours) Geology**

Semester-III

COURSE TITLE: PALAEOONTOLOGY

Course Code: GEOC-303

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 07

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Definition, Branches, scope and application of palaeontology. Fossilization and fossil record, Nature and importance of fossil record; Fossilization processes and modes of preservation.

Marks: 06

Unit 2: Taxonomy and Species concept, Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record.

Marks: 08

Unit 3: Invertebrates, Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance, Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications, Functional adaptation in trilobites and ammonoids.

Marks: 10

Unit 4: Vertebrates, Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs Evolution of horse and intercontinental migrations. Human evolution.

Marks: 10

Unit 5. Introduction to Paleobotany, Gondwana Flora, Introduction to Ichnology.

Marks: 06

Unit 6: Application of fossils in Stratigraphy, Biozones, index fossils, correlation, Role of fossils in sequence stratigraphy; Fossils and paleoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers; Paleocology – fossils as a window to the evolution of ecosystems.

Marks:10

PRACTICALS:

MARKS: 30+ IA 05=35

Study of fossils showing various modes of preservation;

Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils

SUGGESTED READINGS

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
5. Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

Detailed Syllabus for Skill Enhancement Course

Sub: Geology

Semester-III

COURSE TITLE: BASIC FIELD TRAINING

Course Code: GEOS-301

Credits: 02

Total Marks-50

Practical : 40

Course No: SEC- 01

No. of periods: 30

In Semester: 10

Unit 1: Orientation of Topographic sheet in field, marking location in toposheet, Bearing (Front and

back). Concepts of map reading, Distance, height and pace approximation

Unit 2: Identification of rock types in field; structures and texture of rocks, Use of hand lense

Unit 3: Basic field measurement techniques: Bedding dip and strike, Litholog measurement

Unit 4: Reading contours and topography

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Semester-IV

COURSE TITLE: METAMORPHIC PETROLOGY

Course Code: GEOC-401

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 08

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Metamorphism: controls and types. Definition of metamorphism. Factors controlling metamorphism
Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism. Regional metamorphism of argillaceous, calcareous and basic rocks

Marks: 12

Unit 2: Metamorphic facies and grades, Index minerals, Chemographic projections, Metamorphic zones and isogrades. Concept of metamorphic facies and grade Mineralogical phase rule of closed and open system, Structure and textures of metamorphic rocks, General idea about the thermodynamic consideration in metamorphic rock, Equilibrium in metamorphism. Univariant and bivalent reaction and their significance.

Marks: 12

Unit 3: Metamorphism and Tectonism, Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde)

Marks: 10

Unit 4: Migmatites and their origin, Metasomatism and role of fluids in metamorphism

Marks: 08

Unit 5: Metamorphic rock associations- schists, gneisses, khondalites, charnockites, blue schists, eclogites, Khasi greenstone, Slate, phyllite, schist, quartzite, marble amphibolites, granulite, and hornfels.

Marks: 08

PRACTICALS:

MARKS: 30+ IA 05=35

Study of metamorphic rocks in hand specimens,
Study of metamorphic rocks in thin sections,
Study of texture in thin section and hand specimens,
Study of metamorphic phase diagrams

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.

**Detailed Syllabus for Core Course
B.Sc. (Honours) Geology**

Semester-IV

COURSE TITLE: STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Course Code: GEOC-402

Course No: C- 09

Credits: 06 (04-Theory, 02 Practical)

No. of Classes: 96 (48+48)

Total Marks-100

Theory Marks: 65

End Semester: 50

In Semester: 15

Practical Marks: 35

End Semester: 30

In Semester: 05

THEORY:

Unit 1: Principles of stratigraphy, Fundamentals of litho-, bio- and chrono-stratigraphy, Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy).

Marks: 06

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.

Marks: 08

Unit 3: Principles of stratigraphic analysis Facies concept in stratigraphy. Walther's Law of Facies. Concept of paleogeographic reconstruction

Marks: 06

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.

Marks: 08

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

Marks:10

Unit 6: Volcanic provinces of India

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

Marks: 06**Unit 7:** Stratigraphic boundaries. Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary.

Lectures:07 ; Marks:06

PRACTICALS:**MARKS: 30+ IA 05=35**

1. Study of geological map of India and identification of major stratigraphic units.
2. Study of rocks in hand specimens from known Indian stratigraphic horizons
3. Drawing various paleogeographic maps of Precambrian time
4. Study of different Proterozoic supercontinent reconstructions.

SUGGESTED READINGS:

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

**Detailed Syllabus for Core Course
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Semester-IV**COURSE TITLE: HYDROGEOLOGY AND OCEANOGRAPHY****Course Code: GEOC-403****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****End Semester: 50****Course No: C- 10****No. of Classes: 96 (48+48)****Practical Marks: 35****End Semester: 30****In Semester: 15****In Semester: 05****THEORY:**

Unit 1: Introduction and basic concepts. Scope of hydrogeology and its societal relevance. Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of subsurface water. Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers **Marks: 10**

Unit 2: Groundwater flow. Darcy's law and its validity. Intrinsic permeability and hydraulic conductivity. Groundwater flow rates and flow direction. Laminar and turbulent groundwater flow. **Marks: 10**

Unit 3: Well hydraulics and Groundwater exploration. Basic Concepts (drawdown; specific capacity etc). Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers. Surface-based groundwater exploration methods Introduction to subsurface borehole logging methods. **Marks: 10**

Unit 4: Groundwater management. Surface and subsurface water interaction. Groundwater level fluctuations. Basic concepts of water balance studies, issues related to groundwater resources development and management. Rainwater harvesting and artificial recharge of groundwater. **Marks: 10**

Unit 5: Fundamentals of Oceanography:

- General idea of oceanography. Theories on origin of ocean basins.
- Branches of oceanography: Biological oceanography, chemical oceanography, Geological oceanography and physical oceanography. Palaeo-oceanography
- Physical properties of oceans:
Temperature-salinity structure, mixing of waters, surface waves, internal waves, surface tides, internal tides and currents. Pleomorphic aspects of oceans

Marks: 10

PRACTICALS:

MARKS: 30+ IA 05= 35

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

Study, preparation and analysis of hydrographs for differing groundwater conditions

Water potential zones of India (map study).

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

Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

SUGGESTED READINGS:

1. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
3. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. L

Detailed Syllabus for Skill Enhancement Course

Sub: Geology

Semester-IV

COURSE TITLE: GEOLOGICAL MAPPING

Course Code: GEOS-401

Credits: 02

Total Marks-50

Course No: SEC- 02

No. of periods: 30

Practical : 40

In Semester: 10

Unit 1: Geological mapping, stratigraphic correlation

Unit 2: Primary (scalars and vectors) and secondary structures (linear and planar)

Unit 3: Trend, plunge, Rake/Pitch

Unit 4: Stereoplots of linear and planar structures, Orientation analyses

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Semester-V

COURSE TITLE: ECONOMIC GEOLOGY

Course Code: GEOC-501

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 11

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Ores and gangues

Ores, gangue minerals, tenor, grade and lodes, Resources and reserves- Economic and Academic definitions

Marks: 5

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

Marks: 5

Unit 3: 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.

Marks: 12

Unit 4: Overview of Mineral exploration. Exploration techniques. Concept of Remote Sensing, Geophysical and Geochemical Explorations Geological mapping at different scales, drilling, borehole logs and transverse sections.

Marks: 12

Unit 5: Ore grade and Reserve, assessment of grade, reserve estimation

Marks: 6

Unit 6: Metallic and Nonmetallic ores, Metallogenic provinces and epochs. Important deposits of India including atomic minerals. Non-metallic and industrial rocks and minerals, in India. Introduction to gemstones.

Marks: 10

PRACTICALS:

30+ IA 5 =35

Megascopic identification

Study of microscopic properties of ore forming minerals (Oxides and sulphides)

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. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

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Semester-V

COURSE TITLE: GEOMORPHOLOGY

Course Code: GEOC-502

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 12

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Geomorphology and Geomorphological Processes. Endogenic and Exogenic processes **Marks: 5**

Unit 2: Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features. Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya). **Marks: 10**

Unit 3: Exogenic Surficial Processes and geomorphology, Weathering and associated landforms, Hill slopes, Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities. **Marks:15**

Unit 4: Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development. **Marks:10**

Unit 5: Overview of Indian Geomorphology with special reference to NE India, Extra-terrestrial landforms. **Marks: 10**

PRACTICALS:

30+ IA 5=35

Reading topographic maps ,Concept of scale Preparation of a topographic profile , Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index, Morphometry of a drainage basin, Calculating different morphometric parameters , Preparation of geomorphic map , Interpretation of geomorphic processes from the geomorphology of the area

SUGGESTED READINGS:

1. Robert S. Anderson and Suzanne P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

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Semester-V

COURSE TITLE: EXPLORATION GEOLOGY

Course Code: GEOD-501

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: DSE- 1

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Mineral Resources

Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies. **Marks: 10**

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. **Marks: 10**

Unit 3: Evaluation of data

Evaluation of sampling data, Mean, mode, median, standard deviation and variance **Marks:8**

Unit 4: Drilling and Logging

Core and non-core drilling, Planning of bore holes and location of boreholes on ground, Core-logging. **Marks: 10**

Unit 5: Reserve estimations and Errors

Principles of reserve estimation, density and bulk density, 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 **Marks:12**

PRACTICALS:

30+ IA 5=35

1. Identification of anomaly
2. Concept of weighted average in anomaly detection

3. Geological cross-section
4. Models of reserve estimation

SUGGESTED READINGS:

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

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Semester-V

COURSE TITLE: EARTH AND CLIMATE

Course Code: GEOD-502

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: DSE-02

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Climate system: Forcing and Responses, Components of the climate system Climate forcing, Climate controlling factors. Climate system response, response rates and interactions within the climate system. Feedbacks in climate system. **6**

Unit 2: Heat budget of Earth, Incoming solar radiation, receipt and storage of heat. Heat transformation. Earth's heat budget. Interactions amongst various sources of earth's heat. **6**

Unit 3: Atmosphere – Hydrosphere. Layering of atmosphere and atmospheric Circulation. Atmosphere and ocean interaction and its effect on climate. Heat transfer in ocean. Global oceanic conveyor belt and its control on earth's climate. Surface and deep circulation. Sea ice and glacial ice. **12**

Unit 4: Response of biosphere to Earth's climate. Climate Change: natural vs. anthropogenic effects. Humans and climate change. Future perspectives. Brief introduction to archives of climate change. Archive based climate change data from the Indian continent. **8**

Unit 5: Orbital cyclicity and climate. Milankovitch cycles and variability in the climate Glacial-interglacial stages. The Last Glacial maximum (LGM). Pleistocene Glacial-Interglacial cycles. Younger Dryas. Marine isotope stages. **12**

Unit 6: Monsoon. Mechanism of monsoon. Monsoonal variation through time. Factors associated with monsoonal intensity. Effects of monsoon. **6**

PRACTICALS:**30+ IA 5=35**

1. Study of distribution of major climatic regimes of India on map
2. Distribution of major wind patterns on World map
3. Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals
4. Numerical exercises on interpretation of proxy records for paleoclimate

SUGGESTED READINGS:

1. Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
2. Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlatt
3. Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
4. Aguado, E., and Burt, J., 2009. Understanding weather

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Semester-VI**COURSE TITLE: ENGINEERING GEOLOGY****Course Code: GEOC-601****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****End Semester: 50****Course No: C- 13****No. of Classes: 96 (48+48)****Practical Marks: 35****End Semester: 30****In Semester: 15****In Semester: 05****THEORY:****Unit 1:** Engineering Geology and its Scope. Site investigation and characterization **7**

Unit 2: Foundation treatment; Grouting, Rock Bolting and other support mechanisms, Intact Rock and Rock Mass and soil properties. Rock aggregates; Significance as Construction Material. Introduction to alkali aggregate reaction. **7**

Unit 3: Concept, Mechanism and Significance of Rock Quality Designation (RQD) **7**

Concept, Mechanism and Significance of:

a. Rock Structure Rating (RSR)

b. Rock Mass Rating (RMR)

c. Tunneling Quality Index (Q)

Unit 4: Dam and types. Geological, Geotechnical and Environmental considerations associated with Dams and Reservoirs **9**

Unit 5: Geological and geotechnical considerations associated with Roads and Bridges. Tunnels and Tunnelling Methods. **8**

Unit 6: Landslides; Causes, Factors and corrective/Preventive measures, Earthquakes; Causes, Factors and corrective/Preventive measures. **7**

Unit 7: Case histories related to Indian Civil Engineering Projects. Role of Engineering geologists in planning, design and construction of major man-made structural features. Case histories related to Indian Civil Engineering Projects. **5**

PRACTICALS:

30+ IA 5=35

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Merits, demerits & 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 constructions. John Wiley & Sons, N.Y.
4. Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.)Taylor & Francis.
5. Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
6. Bell, .F.G, 2007. *Engineering Geology*, Butterworth-Heineman

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Semester-VI

COURSE TITLE: REMOTE SENSING AND GIS

Course Code: GEOC-602

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: C- 14

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

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. **10**

Unit 2: Remote Sensing, Concepts in Remote Sensing, Sensors and scanners. Satellites, their characteristics and data format. Data formats- Raster and Vector. Indian Remote Sensing Satellites. **12**

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. **12**

Unit 4: GIS, Datum, Coordinate systems and Projection systems. Spatial data models and data editing.Introduction to DEM analysis. **8**

Unit 5: GPS, Concepts of GPS
Integrating GPS data with GIS
Applications in earth system sciences **8**

PRACTICALS:**30+ IA 5=35**

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.

SUGGESTED READINGS:

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.

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Semester-VI**COURSE TITLE: FUEL GEOLOGY****Course Code: GEOD-601****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****Practical Marks: 35****End Semester: 50****End Semester: 30****Course No: DSE- 03****No. of Classes: 96 (48+48)****In Semester: 15****In Semester: 05****THEORY:****Unit 1: 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 **12**

Unit 2: Coal as a fuel

Coal Bed Methane (CBM): global and Indian scenario. Underground coal gasification. Coal liquefaction. **8**

Unit 3: Petroleum

Chemical composition and physical properties of crudes in nature. Origin of petroleum. Maturation of kerogen; Biogenic and Thermal effect. **10**

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. **14**

Unit 5: Other fuels

Gas Hydrate, Shale Oil and Shale Gas. Nuclear Fuel

6

PRACTICALS:

30+ IA 5=35

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Section correlation and identification of hydrocarbon prospect
4. Panel and Fence diagrams

SUGGESTED READINGS:

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

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Semester-VI

COURSE TITLE: RIVER SCIENCE

Course Code: GEOD-602

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: DSE- 04

No. of Classes: 96 (48+48)

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Stream hydrology

Basic stream hydrology, Physical properties of water, sediment and channel flow, River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis Flood frequency analysis. **6**

Unit 2: River Basin

Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment, transport processes in rivers, Erosion and sedimentation processes in channel. **8**

Unit 3: Drainage

Drainage network, Quantitative analysis of network organization – morphometry, Role of drainage network in flux transfer, Evolution of drainage network in geological time scale. **10**

Unit 4: Rivers in time and space

River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels,, Dynamics of alluvial rivers, Channel patterns in stratigraphic sequences, Different classification approaches in fluvial geomorphology and its applications. **10**

Unit 5: Channels and Landscapes

Bedrock channels, Bedrock incision process, River response to climate, tectonics and human disturbance, Bedrock channel processes. **8**

Unit 6: Fluvial hazards

Integrated approach to stream management, Introduction to river ecology. **8**

PRACTICALS:**30+ IA 5=35**

Stream power calculation

Longitudinal profile analysis

Hydrograph analysis and other related problems

SUGGESTED READINGS:

1. Davies, T. (2008) Fundamentals of hydrology. Routledge Publications.
2. Knighton, D. (1998) Fluvial forms and processes: A new perspective. Arnold Pubs.
3. Richards. K. (2004) Rivers: Forms and processes in alluvial channels. Balckburn Press.
4. Bryirely and Fryirs (2005) Geomorphology and river management. Blackwell Pub.,
5. Julien, P.Y. (2002) River Mechanics. Cambridge University Press.
6. Robert, A. (2003) River Processes: An introduction to fluvial dynamics. Arnold Publications.
7. Vanoni, V.A. (2006) Sedimentation Engineering. ASCE Manual, Published y American Society of Civil Engineering,
8. Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American GeophysicalUnionMonogrph, Washington, DC.

Detailed Syllabus for Generic Electives**Sub: Geology****Semester-I****COURSE TITLE: ESSENTIALS OF GEOLOGY****Course Code: GEOG-101****Credits: 06 (04-Theory, 02 Practical)****Total Marks-100****Theory Marks: 65****End Semester: 50****Course No: GE- 01****No. of Classes: 48****Practical Marks: 35****End Semester: 30****In Semester: 15****In Semester: 05****THEORY:****Unit 1:** Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences**Marks: 04****Unit 2:** Earth in the solar system, origin**Marks: 12**

Earth's size, shape, mass, density, rotational and evolutionary parameters

Solar System- Introduction to Various planets - Terrestrial Planets

Solar System- Introduction to Various planets - Jovian Planets

Internal constitution of the earth - core, mantle and crust

Unit 3: Convections in the earth's core and production of magnetic field**Marks: 10**

Composition of earth in comparison to other bodies in the solar system

Unit 4: Origin and composition of hydrosphere and atmosphere**Marks: 12**

Origin of biosphere

Origin of oceans, continents and mountains

Unit 5: Age of the earth; Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils

Marks: 12

Internal Assessment

Marks: 15

Periods: 30

PRACTICALS:

Marks: 30+ IA 5=35

1. Study of major geomorphic features and their relationships with outcrops through physiographic models.
2. Detailed study of topographic sheets and preparation of physiographic description of an area
3. Study of soil profile of any specific area
4. Study of distribution of major lithostratigraphic units on the map of India
5. Study of distribution of major dams on map of India and their impact on river systems
6. Study of major ocean currents of the World
7. Study of seismic profile of a specific area and its interpretation

SUGGESTED READINGS:

1. Holmes' Principles of Physical Geology. 1992. Chapman & Hall.
2. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.
3. Gross, M.G., 1977. *Oceanography: A view of the Earth*, Prentice Hall.

Detailed Syllabus for Generic Electives Sub: Geology

Semester-II

COURSE TITLE: ROCKS AND MINERALS

Course Code: GEOG-201

Course No: GE- 02

Credits: 06 (04-Theory, 02 Practical)

No. of Classes: 48

Total Marks-100

Theory Marks: 65

End Semester: 50

In Semester: 15

Practical Marks: 35

End Semester: 30

In Semester: 05

THEORY:

Unit 1: Minerals-Definitions, Physical properties of minerals
Mineralogical structure of earth, planetary minerals and native elements

Marks: 6

Unit 2: Mineral structures
Mineralogy of the Earth's crust, mantle and core

Marks: 12

Unit 3: Nature of light and principles of optical mineralogy
Optical classification of minerals.
An overview of environmental and radiation mineralogy, biomineralisation and gemology.

Marks: 12

Unit 4: Rocks- Definitions and types, Basics of rock formation.
Igneous rock- magma generation and differentiation
Sedimentary rocks- surface processes and sedimentary environments
Metamorphic rocks- chemical system and types of metamorphism

Marks: 18

Rock cycle-interactions between plate tectonics and climate systems

Internal Assessment

Marks: 15

PRACTICALS:

30+ IA 5=35

1. Study of physical properties of minerals
 2. Introduction to optical microscopy
 3. Study of optical properties of minerals
 4. Study of physical properties of rocks
 5. Study of optical properties of rock under thin sections
 6. Understanding crystal symmetry via wooden models
 7. Stereographic projection of mineral faces
- Viva + Practical Note Book

SUGGESTED READINGS:

1. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.
2. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and company, New York.

**Detailed Syllabus for Generic Electives
Sub: Geology**

Semester-III

COURSE TITLE: PHYSICS AND CHEMISTRY OF EARTH

Course Code: GEOG-301

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: GE- 03

No. of Classes: 48

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Earth: surface features, Continents, continental margins, oceans **Marks: 10**

Unit 2: Earth's interior - variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities. Concepts of Isostasy; Airy and Pratt Model Core: Seismological and other geophysical constraints. The geodynamo - Convection in the mantle. **Marks: 10**

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Unit 3: Elements of earth's magnetism. Secular variation and westward drift. Solar activity and magnetic disturbance. **Marks: 08**

Unit 4: Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system / planet earth, Geochemical classification of elements. Earth accretion and early differentiation, Isotopes and their

applications in understanding Earth processes., Stable isotopes: Stable isotope fractionation. Oxygen isotopes
Sublithospheric Mantle (Mineralogy/phase transitions). **Marks: 12**

Unit 5: Environmental geochemistry Geological disposal of nuclear waste. Lead in environment and effect of
lead on human health. **Marks: 10**

PRACTICALS:

MARKS: 30+ IA 05=35

1. Projection of major elements on binary and triangular diagrams for rock classification
2. Projection of major element data on Harker's diagram to characterize magmatic differentiation
3. Study of trace elements through a) Projection of chondrite/primitive normalized trace elements to characterize sources b) Projection of trace elements on tectonic discrimination diagrams
4. Understanding Earth structure through behavior of seismic wave propagation
5. Problems on isostasy

SUGGESTED READINGS:

1. Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
2. Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
3. Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill
4. Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
5. Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
6. Steiner, E. (2008). The chemistry maths book. Oxford University Press.
7. Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press.

Detailed Syllabus for Generic Electives

Sub: Geology

Semester-IV

COURSE TITLE: EARTH RESOURCES

Course Code: GEOG-401

Credits: 06 (04-Theory, 02 Practical)

Total Marks-100

Theory Marks: 65

Practical Marks: 35

End Semester: 50

End Semester: 30

Course No: GE- 04

No. of Classes: 48

In Semester: 15

In Semester: 05

THEORY:

Unit 1: Earth Resources, Resource reserve definitions; mineral, energy and water resources in industries. Historical perspective and present. A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies **Marks: 12**

Unit 2: Definition of Energy: Primary and Secondary Energy Difference between Energy, Power and Electricity Renewable and Non-Renewable Sources of Energy. The concept and significance of Renewability: Social, Economic, Political and Environmental Dimension of Energy. **Marks: 12**

Unit 3: Major Types and Sources of Energy, Resources of Natural Oil and Gas. Coal and Nuclear Minerals. Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based power and Energy.

Marks: 14

Unit 4: Energy Sources and Power Generation: Nuclear, Hydroelectric, Solar, Wind and Wave- General Principles. Ground water resources and its role in economic development of a country Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells.

Marks: 14**PRACTICALS:****MARKS: 30+ IA 05=35**

1. Plotting of major Indian oil fields on map of India
2. Problems related to hydroelectric power generation
3. Problems related to assessment of possible oil exploration site from geological maps
4. Problems related to energy demand projection of India and possible mitigation pathways
5. Problems related to biofuel

SUGGESTED READINGS:

1. Energy and the Environment by Fowler, J.M 1984. McGraw-Hill
2. Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.
3. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M. A. Prells. 2009, Springer
4. Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.
5. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.